EDISON ELECTRIC INSTITUTE BULLETIN

JULY, 1942

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EDISON ELECTRIC INSTITUTE

THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

April, 1942

SOURCE AND DISPOSAL OF ENERGY—MONTH OF APRIL

	1942	1941	%
GENERATION* (Net)			
By Fuel Burning Plants	8,983,217,000	8,054,400,000	+11.5
By Water Power Plants	5,602,669,000	4,828,000,000	+16.0
Total Generation	**14,585,886,000**	**12,882,400,000**	**+13.2**
Add—Net Imports Over International Boundaries	Details	76,337,000	.....
Less—Company Use	Not	149,696,000	.....
Less—Energy Used by Producer	Yet	252,611,000	.....
Net Energy for Distribution	Available)	12,556,430,000	.....
Losses and Unaccounted For		1,626,835,000	.....
Sales to Ultimate Customers	**12,536,014,000**	**10,929,595,000**	**+14.7**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of April 30th			
Residential or Domestic	26,203,806	25,185,950	+ 4.0
Rural (Distinct Rural Rates)	1,083,732	938,672	.....
Commercial or Industrial:			
Small Light and Power	4,311,739	4,257,602	+ 0.7
Large Light and Power	148,920	172,550	
Other Customers	120,966	117,356	.....
Total Ultimate Customers	**31,869,163**	**30,672,130**	**+ 3.9**
KILOWATTHOUR SALES—During Month of April			
Residential or Domestic	2,139,228,000	1,990,113,000	+ 7.5
Rural (Distinct Rural Rates)	205,583,000	132,539,000	+55.1
Commercial or Industrial:			
Small Light and Power	2,156,102,000	1,925,304,000	+ 6.8**
Large Light and Power	6,988,211,000	5,941,210,000	+19.5**
Street and Highway Lighting	158,402,000	159,882,000	− 0.9
Other Public Authorities	293,850,000	241,045,000	+21.9
Railways and Railroads:			
Street and Interurban Railways	336,319,000	318,134,000	+ 5.7
Electrified Steam Railroads	188,864,000	166,902,000	+13.2
Interdepartmental	69,455,000	54,466,000	+27.5
Total to Ultimate Customers	**12,536,014,000**	**10,929,595,000**	**+14.7**
Revenue from Ultimate Customers	**$227,610,300**	**$210,703,800**	**+ 8.0**

** Based on Changes Made in Same Classifications Both Years.

RESIDENTIAL OR DOMESTIC SERVICE (Revised Series)

AVERAGE CUSTOMER DATA—For the 12 Months Ended April 30th			
Kilowatthours per Customer	1,005	966	+ 4.0
Average Annual Bill	$37.19	$36.71	+ 1.3
Revenue per Kilowatthour	3.70¢	3.80¢	− 2.6

* By Courtesy of the Federal Power Commission.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 10 JULY, 1942 No. 7

Idle Electric Generating Capacity

Put It to Work in War Production

SUMMARY

The enormous war need for Electric Power, successfully met and provided for to date, has not exhausted all the possibilities for coordinated operation of the power supply. In fact, a study made early in 1942 by Ebasco Services Incorporated of a number of operating utility systems shows that there is one source of power that has not been cataloged and utilized to its fullest extent. This added source of power is the interconnection of industrial and municipal power plants with utility systems.

There is nothing new in this source of power; many utility companies have utilized it for years, particularly in cases involving large single blocks of power. What is new, though, is the extent of the study, in that it embraces all industrial and municipal power plants in the territories of a large number of utility operating companies.

The study indicates that there is a way to increase the country's availability of electric generating capacity by something like 3,000,000 kilowatts without building a single new power plant. The cost of making this capacity available is estimated as about 25% of the cost of building new steam stations.

The second part of this study analyzes what results might be secured were it possible in wartime to increase the load factor of all existing electric systems—private utility, federal, municipal and industrial. By increasing the load factor on these systems to 85%, is is estimated that the yearly output could be increased by 80 billions of kilowatt-hours. This estimate of national potentialities for added energy is based on data available on the operating companies studied. Realization of potentialities would depend, of course, on a basic plan to run industrial plants generally on a 2 or 3 shift basis—rather than to keep on building new plants.

This study was made to show a factual situation and the resulting figures, while not precise for use in working out final programs, do show potentialities far too great to be neglected or ignored in wartime economy. The scope of a report of this nature is necessarily limited. For instance, conditions are constantly changing; many diverse interests would have to be coordinated to put such a plan into effect; much higher load factors may not be possible in many industries and localities; industrial and municipal power plants may not be located in places where a power shortage may occur; there may be a shortage of even the limited materials needed to make the requisite interconnections; and, most important of all, human nature is involved in each of the multitudinous negotiations which would be necessary to put such a plan into operation.

Through the courtesy and cooperation of Ebasco Services Incorporated this study is here presented both for its intrinsic interest and to direct further attention to a field which clearly warrants further study and analysis, particularly in those areas where a power shortage may be threatened. In any event, the job is one for the "know how" men who are experienced and thoroughly familiar with the operation and capabilities of their equipment and have successfully carried the war and necessary civilian electric loads so far. These men can continue to carry all the essential loads if "getting the job done" is left in their hands.

WAR demands for electric power are huge. Army camps, bomber plants, chemical plants, magnesium plants, explosive plants, call for kilowatts by the tens of thousands. A single new aluminum project in one Southern State will use more kilowatts and kilowatt-hours per year than all the electric loads previously developed in that State in the last fifty years.

The United States has enormous electric power resources, in four main categories. First, and predominant, are the great electric utility company systems which contribute about seven-eighths of the public power supply. Second come the large Federal hydro systems created in the last few years and a few large municipal systems, which together make up most of the rest of the public power supply. Third come many large mining, industrial, railroad and similar companies, especially in the chemical and metallurgical fields, which have customarily installed and operated their own electric equipment. Fourth are numerous industrial concerns and smaller municipal plants serving many isolated loads, usually quite small individually, but numerous in aggregate on a nation-wide basis.

In the present war production program, the power *capacity* resources of the first three classes are now well cataloged and either already closely coordinated and integrated for maximum production or shortly to be so according to plans and techniques now well formulated.

The possibilities of increasing the country's effective and useable electric power supply by fullest possible coordination, and interconnected operation, of the smaller isolated plants in the fourth category have, to date, received less attention. This memorandum has been prepared primarily to point out the important possibilities for putting such capacity more fully to work. It is based on studies which show that potential power "shortages" can be forestalled or much reduced by such steps. It shows that despite the enormous war needs for electric power, already successfully met or provided for, the cupboard isn't yet as bare as many people think. They have merely neglected to look on all the shelves.

Enormous Capacity, Now Unutilized Is Already Installed

There is a way to increase the country's use of electric generating *capacity* by something like 3,000,000 kilowatts, without building any new power plants.

There is a way to increase the supply of electric energy by a huge amount, possibly something like 80 billion kilowatt-hours per year, without enormous money spending, and without noticeably depriving the armed forces of ships and planes and guns and tanks.

It could all be done with use of only small amounts of copper and other critical war material, and at an average cost per kilowatt of capacity gained of probably less than 25% of the cost of new power stations for the same purpose.

The figures are necessarily approximate. But they are based on a careful preliminary survey of systems comprising a representative sample of the national resources, constituting about 10% of the national total. No matter how much, within reason, they may be discounted by virtue of their preliminary nature, they demonstrate exceeding merit for the plan. A little later on it will be shown why the figures may be too high, or again why they may be too low. The further factors which may be developed by a detailed approach tend to cancel each other in considerable degree.

Why Present Official Figures of Power Capacity Are Deficient

Many official reports on power generating capacity and electric energy available therefrom, and on estimated electric power needs for war production plus probable civilian requirements, have been made public. They have caused quite wide public concern as to the potential adequacy of the war power supply.

The power-production capacity figures have been derived from results of surveys, responses to questionnaires, utility reports to regulatory authorities, operating statements made for various purposes, and similar statistical tabulations. Such data are in the main correct as to conventional ratings, peace-time operating methods and normal performance. They are statistics of large and helpful significance for analyzing conditions and trends in normal times.

But statistics won't win a war. Indispensable as they may be, they have characteristic weaknesses which skilled and experienced men recognize and allow for in using them wisely as bases for prognostications—or what really are educated guesses as to what the future may bring forth. But for war use such statistics fail in at least two fundamental respects.

First, they are incomplete, as will be shown later on.

Second, they are of necessity condensations and generalizations. They are in simplified form which facilitates arithmetical totalizing, averaging and such processes. They achieve such simplicity, however, by neglect of differences in basic operating equipment and personnel which may be overlooked only so long as normal conditions, tolerances and reserves prevail, but which cannot be ignored when the job is to get out the "last ounce." It may be statistically correct to tell a colonel that there are 275 men in his regiment who are 5 feet 8 inches tall. But it doesn't tell him all that he can count on these men to do, by a long shot.

In other words, statistics based on normal ratings and performances do not reflect what may be called the hidden reserves of individual capacities and capabilities that may be called forth by experienced local operators, under urgent circumstances. This is a field quite beyond the scope of statistical analysis and remote official interpretation. It is well known to practical men that machines, like people, have abilities such that those who live with them and know them are able in a pinch to invoke "extra" performance that isn't engraved on manufacturers' nameplates or comprehended in run-of-mine statistics.

The foregoing digression is made to emphasize one cardinal requirement of the plan suggested below. That plan—or any other aimed at fullest practicable output—won't work through arms-length statistics and remote control. It won't even work right, and to the degree now necessary for Victory, under hastily improvised local bureaus, superimposed on basic local operating and regulatory organizations but strange to all concerned and to the systems which must turn out the power.

The plan will work, to the vast relief of official worriment, if left basically to the operation of those who know how. Despite all prior disturbing prophecies to the contrary, the war electric load *and* the civilian electric load have so far been carried safely by the country's "know how" men. These men can continue to carry all essential loads if they be allowed to perform.

The Plan Proposed

Peeled down to fundamentals, it is simply proposed herein to make fullest possible use of all of the country's presently installed electric generating capacity, plus the additional capacity definitely in sight as it comes from the manufacturers and is rushed into service.

Note that the plan has two fundamental aspects. First, to use all available capacity. Second, to use it to the fullest possible extent.

An enormous, aggregate margin of idle capacity has so far been left out of the official figures on which shortage predictions have been based. In typical areas, the maximum use of capacity already in place in hundreds of isolated industrial and municipal plants is two-thirds or less of their installed capacity. The additional energy which could be produced continuously by such excess capacity is greater than the present total output of such plants.

It is entirely feasible to interconnect the great majority of such plants, quickly, with present power systems constituting the source of the present public power supply. So tied-in, their excess capacity can be put to work carrying system loads immediately adjacent to such currently isolated plants. Equivalent capacity in present central stations can thus be made available simultaneously for new war loads. By such means it is possible to use all available installed capacity.

The second step, once all available capacity is so interconnected and coordinated in operation, is to use all such capacity—whether in present utility systems or present isolated plants—for more hours per day, more hours per week, more hours per year. Such better utilization of total capacity through improvement of load factor and better scheduling of war and essential civilian production in all industrial and other establishments constitutes the second phase of the plan herein outlined. The two phases are separable to a wide degree but both should be used to get maximum war production, both of electric power and of the munitions, products and services which flow from use of such electric power.

In essence, to make idle capacity available, *all* possible electric power-producing properties in each local territory and regional area must be tied in to a general transmission and distribution system along with present central station properties, so that each such regional producing unit shall be operated as nearly as possible up to its maximum output capacity.

This may be called a "bits and pieces" plan. The job is not subject to much broad generalization, nor may it be solved by statistical formulae. The smaller the bits and pieces, the less they are susceptible of analysis by methods founded on the premise of close similarity of individual statistical units. The opportunity of success rests in coordinating their differences, not in assuming their identity and cranking an adding machine.

The job is to place responsibility on local electric plant owners and opera-

tors, first, to get together; second, to integrate their facilities; third, to generate every "bit" of electricity which each available "piece" of equipment can be made to put out.

And let it be clear that the objective is maximum production, not economy, profits or conventional business operation. "Low grade"—and, therefore, high cost—capacity must be run, as well as huge, modern, efficient units, in whatever hours *both* are needed to get production now. It has rightly been said that one weapon in 1942 may well be worth ten in 1943 or 1944. It is a peculiar and timely virtue of any kilowatt-hour that it will do just as much work whether produced from high, low or medium cost generating facilities. It is the work which is vital now. Economics can be adapted to war needs in making electricity just as much as in any other line of production.

The underlying war principle here is precisely that which animates the whole national effort for procurement of all-out war materials production. To that end it is now the rule that the manufacturing plants of the country shall, whenever necessary, be converted to war production, shall operate in coordination, and shall utilize in common all materials, labor, executive capacity and processes as though the manufacturing plants were under one ownership and management for the duration of the national crisis.

In such fashion, the electric generating equipment of the public utilities and of the manufacturing plants and of the publicly-owned systems, should be tied together under the joint responsibility and management of the respective plant owners, precisely according to the plan now in effect as to war-manufacturing industrial plants. Let the "know how" men do it.

Potentialities for Using Idle Capacity

A survey by a representative group of 23 electric utility companies, operating in important parts of 24 States and in 6 major geographic regions of the United States, indicates the potentialities for putting presently idle electric generating capacity to work.

The diagram of a typical daily "Load Curve" of an isolated industrial or municipal plant, Fig. 1, page 253, visualizes the program and its possibilities. The curve shows, for such a plant, total installed electric generating capacity; the actual loads carried by such capacity for each hour of the day (heavy black line); and, cross-hatched at the top of the diagram, the unused capacity in excess of the peak actual demand. Such unused capacity is not employed at any time during the whole 24 hours of the day. Briefly, the first element of the plan herein proposed is to put such unused capacity to work in the war production effort.

Table I speaks for itself. For the areas covered by the 23-company survey, it indicates these results:

Table I—Industrial and Municipal

Estimated Electrical Generating Capacity and Energy Available in Excess of 1941 Demands and Output from Industrial and Municipal Power Plants Reasonably Capable of Interconnection with Present Utility Systems of 23 Representative Electric Operating Companies.

Company	Estimated Generating Capacity Industrial and Municipal Power Plants			Estimated Annual Electric Energy Production Industrial and Municipal Power Plants	
	Installed Capacity (Kilowatts)	Present Maximum Demands (Kilowatts)	Unused Capacity (Kilowatts)	Annual Output 1941 (Kilowatt Hours)	Additional Energy Which Could Be Produced From Unused Capacity If Operated 85% of The Hours of the Year (Kilowatt Hours)
	I	II	III	IV	V
Company A	15,400	8,300	7,100	63,400,000	53,000,000
" B	7,300	6,500	800	19,300,000	5,900,000
" C	27,400	20,700	6,700	81,800,000	49,000,000
" D	10,300	5,700	4,600	11,200,000	34,800,000
" E	9,300	7,300	2,000	14,100,000	14,300,000
" F	43,000	27,000	16,000*	106,600,000	88,200,000
NW Group-Total	112,700	75,500	37,200	296,400,000	245,200,000
Company G	39,900	23,700	16,200	91,000,000	120,600,000
" H	5,500	1,300	4,200	3,400,000	31,600,000
" I	56,800	32,000	24,800	138,400,000	184,400,000
" J	3,100	2,300	800	3,100,000	5,700,000
NC Group-Total	105,300	59,300	46,000	235,900,000	342,300,000
Company K	92,300	66,700	25,600	304,800,000	190,700,000
NE Group-Total	92,300	66,700	25,600	304,800,000	190,700,000
Company L	46,200	18,200	28,000	78,900,000	209,300,000
" M	116,200	65,400	50,800	274,900,000	379,000,000
" N	3,300	1,700	1,600	3,200,000	11,900,000
SE Group-Total	165,700	85,300	80,400	357,000,000	600,200,000
Company O	38,800	27,500	11,300	115,100,000	83,600,000
" P	75,000	47,200	27,800	165,600,000	207,300,000
" Q	27,800	15,200	12,600	51,800,000	92,800,000
" R	31,400	8,100(b)	23,300(a)	37,000,000	161,000,000
SC Group-Total	173,000	98,000	75,000	369,500,000	544,700,000
Company S	13,800	6,600	7,200	25,000,000	52,900,000
" T	20,900	11,700	9,200	44,500,000	67,800,000
" U	14,400	8,000	6,400	32,000,000	46,900,000
" V	7,500	2,400	5,100	13,400,000	37,800,000
" W	1,100	100	1,000	100,000	7,500,000
SW Group-Total	57,700	28,800	28,900	115,000,000	212,900,000
TOTAL	706,700	413,600	293,100	1,678,600,000	2,136,000,000

Data in Columns I, II, III, IV supplied by 23 utilities

Data in Column V is Column III x 8760 x 0.85

* Capacity of some plants may be limited some months by deficient stream flow or fuel supply

(a) Includes and (b) excludes 21,000 KW of capacity available about 97% of total hours per year

The 1941 energy output of the plants covered by the foregoing tabulation was approximately 1,678,600,000 kilowatt-hours. If the 293,100 kilowatts of Unused Capacity were to have been run continuously, the *additional* annual energy output from such Unused Capacity would have been about 2,567,500,000 kilowatt-hours. Run 85% of the time, as is shown in Table I, such Unused Capacity alone could have turned out 2,136,000,000 kilowatt-hours.

Estimated Generating Capacity in 23 Isolated Plants Capable of Coordination with Electric Utility Systems

Region	*Installed Capacity Kilowatts*	*Present Maximum Demands Kilowatts*	*Unused Capacity Kilowatts*
North West (6 Cos)	112,700	75,500	37,200
North Central (4 Cos)	105,300	59,300	46,000
North East (1 Co)	92,300	66,700	25,600
South East (3 Cos)	165,700	85,300	80,400
South Central (4 Cos)	173,000	98,000	75,000
South West (5 Cos)	57,700	28,800	28,900
Totals (23 Cos)	706,700	413,600	293,100

TABLE II—INDUSTRIAL

Estimated Electrical Generating Capacity and Energy Available in Excess of 1941 Demands and Output from Industrial Power Plants Reasonably Capable of Interconnection with Present Utility Systems of 23 Representative Electric Operating Companies.

Company	Estimated Generating Capacity Industrial Power Plants			Estimated Annual Electric Energy Production Industrial Power Plants	
	Installed Capacity (Kilowatts)	Present Maximum Demand (Kilowatts)	Unused Capacity (Kilowatts)	Annual Output 1941 (Kilowatt Hours)	Additional Energy Which Could Be Produced From Unused Capacity If Operated 85% of the Hours of the Year (Kilowatt Hours)
	I	II	III	IV	V
Company A	15,400	8,300	7,100	63,400,000	53,000,000
" B	6,900	6,500	400	19,300,000	2,700,000
" C	22,300	16,100	6,200	58,200,000	45,200,000
" D	10,300	5,700	4,600	11,200,000	34,800,000
" E	7,100	5,300	1,800	10,500,000	13,100,000
" F	19,200	11,300	8,000 *	44,900,000	59,100,000
NW Group - Total	81,300	53,200	28,100	207,500,000	207,900,000
Company G	11,600	9,800	1,800	38,500,000	13,200,000
" H	4,000	400	3,600	400,000	27,000,000
" I	34,000	23,500	10,500	102,800,000	77,600,000
" J	3,100	2,300	800	5,100,000	4,700,000
NC Group - Total	52,700	36,000	16,700	144,800,000	123,500,000
Company K	80,600	59,900	20,700	263,000,000	154,000,000
NE Group - Total	80,600	59,900	20,700	283,000,000	154,000,000
Company L	9,800	3,600	6,200	19,400,000	46,500,000
" M	15,900	9,500	6,400	26,800,000	48,000,000
" N	3,300	1,700	1,600	3,200,000	11,900,000
SE Group - Total	29,000	14,800	14,200	49,400,000	106,400,000
Company O	23,200	20,500	2,700	93,200,000	19,800,000
" P	35,100	24,900	10,200	87,400,000	75,700,000
" Q	9,500	6,400	3,100	22,400,000	22,300,000
" R	3,400	2,100	1,300	7,000,000	10,000,000
SC Group - Total	71,200	53,900	17,300	210,000,000	127,800,000
Company S	13,700	6,600	7,100	25,000,000	52,200,000
" T	6,600	3,200	3,400	19,000,000	25,100,000
" U	8,900	4,800	4,100	20,700,000	29,800,000
" V	7,500	2,400	5,100	13,400,000	37,800,000
" W	900	100	800	100,000	5,700,000
SW Group - Total	37,600	17,100	20,500	78,200,000	150,600,000
TOTAL	352,400	234,900	117,500	972,900,000	870,200,000

Data in Columns I, II, III, IV supplied by 23 utilities

Data in Column V is Column III x 8760 x 0.85

* Capacity of some plants may be limited some months by deficient stream flow or fuel supply

TABLE III—MUNICIPAL

Estimated Electrical Generating Capacity and Energy Available in Excess of 1941 Demands and Output from Municipal Power Plants Reasonably Capable of Interconnection with Present Utility Systems of 23 Representative Electric Operating Companies.

Company	Estimated Generating Capacity Municipal Power Plants			Estimated Annual Electric Energy Production Municipal Power Plants	
	Installed Capacity (Kilowatts)	Present Maximum Demands (Kilowatts)	Unused Capacity (Kilowatts)	Annual Output 1941 (Kilowatt Hours)	Additional Energy Which Could Be Produced From Unused Capacity If Operated 85% of The Hours of the Year (Kilowatt Hours)
	I	II	III	IV	V
Company A	-	-	-	-	-
" B	400	-	400	-	3,200,000
" C	5,100	4,600	500	23,600,000	3,800,000
" D	-	-	-	-	-
" E	2,200	2,000	200	3,600,000	1,200,000
" F	23,700	15,700	8,000 *	61,700,000	29,100,000
NW Group - Total	31,400	22,300	9,100	88,900,000	37,200,000
Company G	28,300	13,900	14,400	52,500,000	107,400,000
" H	1,500	900	600	3,000,000	4,600,000
" I	22,800	8,500	14,300	35,600,000	106,800,000
" J	-	-	-	-	-
NC Group - Total	52,600	23,300	29,300	91,100,000	218,800,000
Company K	11,700	6,800	4,900	21,800,000	36,700,000
NE Group - Total	11,700	6,800	4,900	21,800,000	36,700,000
Company L	36,400	14,600	21,800	59,500,000	162,800,000
" M	100,300	55,900	44,400	248,100,000	331,000,000
" N	-	-	-	-	-
SE Group - Total	136,700	70,500	66,200	307,600,000	493,800,000
Company O	15,600	7,000	8,600	21,900,000	63,900,000
" P	39,900	22,300	17,600	78,200,000	131,600,000
" Q	18,300	8,800	9,500	29,400,000	70,500,000
" R	28,000	6,000(b)	22,000 (a)	30,000,000	151,000,000
SC Group - Total	101,800	44,100	57,700	159,500,000	416,900,000
Company S	100	-	100	-	700,000
" T	14,300	8,500	5,800	25,500,000	42,700,000
" U	5,500	3,200	2,300	11,300,000	17,100,000
" V	-	-	-	-	-
" W	200	-	200	-	1,800,000
SW Group - Total	20,100	11,700	8,400	36,800,000	62,300,000
TOTAL	354,300	178,700	175,600	705,700,000	1,265,800,000

Data in Columns I, II, III, IV supplied by 23 utilities

Data in Column V is Column III x 8760 x 0.85

* Capacity of some plants may be limited some months by deficient stream flow or fuel supply

(a) Includes and (b) excludes 21,000 Kw of capacity available about 97% of total hours per year

Tables II and III show how the Unused Capacity divides in the respective company territories between that in industrial and that in municipal plants.

National Potentialities—The 23-company group comprises operating utility systems with aggregate installed electric generating capacity of 3,071,300 kilowatts. They produced 14,099,515,000 kilowatt-hours of electrical energy in 1941. They represent 8.5% of the corresponding national generating capacity of such types of system and 9.8% of the output of such systems.

The territories of the 23 operating companies are a fairly representative cross-section of the United States geographically, except that their service territories typically contain less than an average amount of the dense, metropolitan industrial type of business.

However, accepting the results of their survey as representing a reasonably good national sample, their data indicate that for the United States as a whole, approximately 3,000,000 kilowatts of presently unused generating capacity in isolated industrial and municipal plants is available to be put to work at war production.

The national situation may also be analyzed roughly in another way. Available national data indicate that aggregate installed capacity in Industrial & Mining, Municipal, and Railway & Miscellaneous power plants in 1941 was 17,800,000 kilowatts; and that the sum of the peak demands carried by such plants in that year was about 12,000,000 kilowatts. The excess or unused capacity on such basis was about 5,800,000 kilowatts.

If half of such excess were in plants, such as those considered in the 23-company survey, which are readily capable of prompt interconnection with present utility systems, the idle capacity which might so be put to work would be slightly under 3,000,000 kilowatts. Such an assumption seems not unreasonable and such result, it may be noted, is about the same as that arrived at by extrapolating the results of the survey group's figures.

Before discussing the factors which may make the results of the preliminary survey high or low, it is worth noting that added generating capacity of 3,000,000 kilowatts would be about 1.20 times the capacity of all new generating capacity added to the country's utility systems in 1941; and is substantially equal to the corresponding incremental new capacity which it seems probable will actually be installed in the current year of 1942. The relative costs for such capacity will be discussed a little later on.

Usefulness of Survey Data—The preliminary survey made by the 23 operating electric companies, and summarized in this memorandum, is based on actual visits to each isolated plant in their respective territories, on which visit experienced industrial sales engineers secured information on plant capacity, output and load carried. Such data were supplemented by rough engineering estimates of the materials and money costs required to tie such isolated plants to the nearest feasible utility lines, or substation, for interconnected operation.

The resultant figures as to possibly useable idle capacity are those summarized in Table I. They may be somewhat higher or somewhat lower than those which could actually be achieved on putting the plan into effect.

Factors which may make the figures as to useable, idle capacity too low are:

1—No diversities as to maximum demands on individual power plants and utility systems have been taken into consideration. The figures involve the assumption that all maximum demands occur at the same time. Obviously then, the actual amount of capacity and energy to be derived from an all-out interconnection of this character would be considerably greater than that so computed.

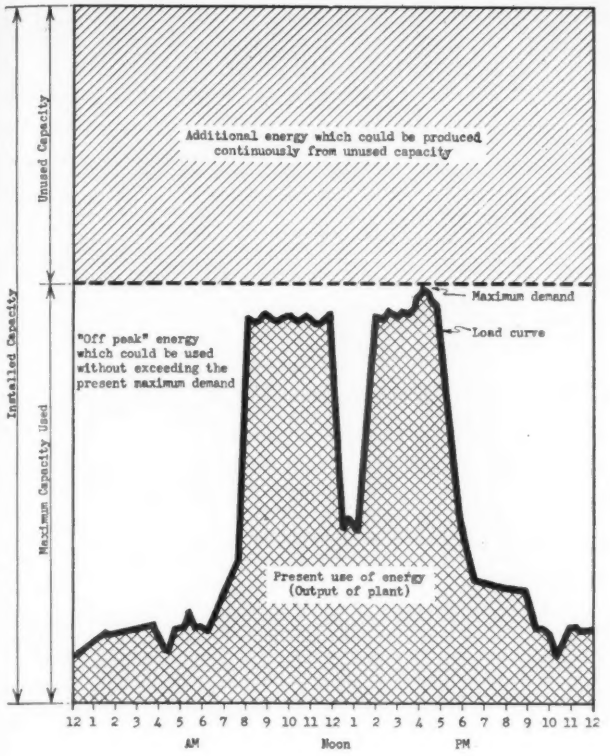
Unused Capacity
Installed Capacity
Maximum Capacity Used
Additional energy which could be produced continuously from unused capacity
Maximum demand
Load curve
"Off peak" energy which could be used without exceeding the present maximum demand
Present use of energy (Output of plant)
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
Noon
PM

Fig. 1—Diagram of a Daily Load Curve

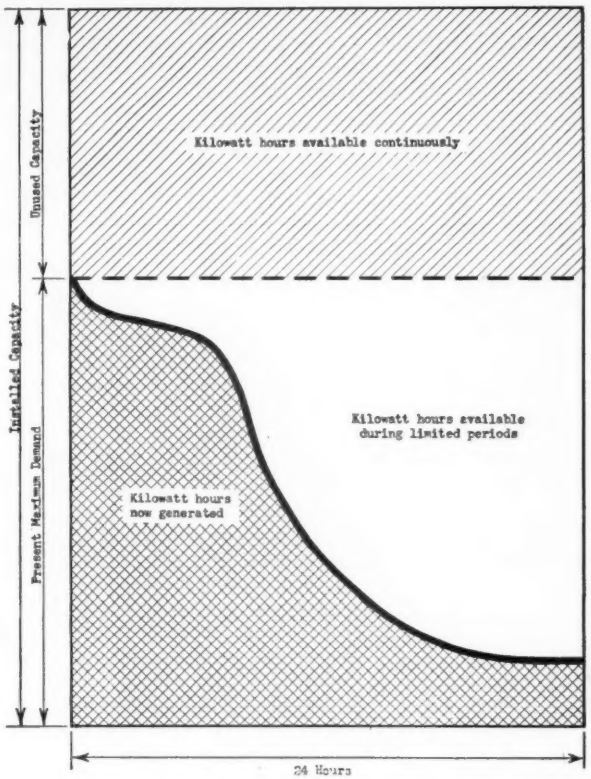

Fig. 2—Load Duration Curve

2—All plants having an installed generating capacity less than 100 kilowatts have been excluded from these computations. It is well known that on an urgent war production basis many small plants of such character could wisely and productively be included in the general interconnected systems.

3—All plants with direct current generation have been excluded; by using available motor-generator equipment, some such plants could undoubtedly be interconnected.

4—Plants which would require disproportionately high cost to interconnect to utility facilities, as compared with cost of equivalent new capacity, have been excluded; some such facilities could be made available, even at such high cost, in an hour of real necessity.

5—Additional yield of energy could be secured by improving the power factors of numerous individual plants.

6—Many of the power plants can be made to produce more energy than their normal rating by overloading the generating equipment for limited periods.

7—Some of the power plants could be markedly improved in production if they were reconditioned.

8—By discriminately rescheduling the production methods in both war and other industries, it may well be possible to reduce some of the existing peak-load demands for power, and thus release corresponding additional capacity for other purposes.

Other factors whch may offset in large or small degree the eight favorable factors above enumerated, and so make the figures as to useable, idle capacity too high, are:

(a) Some plants may not, by reason of old or inefficient equipment, be able to produce energy at their rated capacity.

(b) Some power plants supplying war industries may, since this survey was made, have taken on additional war load, and, therefore, some of the space capacity shown in the tables may no longer be present.

(c) In some regions there may be difficult fuel problems to complicate the situation.

(d) In some plants there may be limitations due to deficient boiler or accessory capacity, so that these parts of the plant do not measure up to the electric generator capacity.

(e) Under present conditions of war production it may be difficult to obtain the repair parts necessary to recondition old power plants.

(f) Skilled labor to operate power plants under full load conditions is becoming more difficult to obtain.

(g) Possible shutdowns necessary for repair or maintenance purposes may make the useable capacity less than that tabulated or available for fewer hours per year.

It cannot be stated in advance what the final effect of all the factors, pro and con, may be. The two sets of factors tend, roughly, to cancel each other. In any event, the results are sufficiently accurate to indicate the importance of further investigation, in all service areas, of the potential capacity available from these presently untapped sources. They are also good enough to show that the day of power rationing, or of diversion of critical materials and labor from munitions to erection and equipping of further new power plants, can definitely be deferred for some time yet in most parts of the nation.

Additional Energy From Load Factor Improvement

The daily load, Fig. 1, has been replotted in Fig. 2 in the form of a daily "Load Duration" diagram. This visualizes more easily the possibility of longer-hour use of capacity *now* carrying present demands.

The possible output from presently unused "excess" installed capacity is cross-hatched at the top of the latter diagram just as in the original hourly load curve for the typical day covered by that curve. The present energy output is represented by the double cross-hatched area under the heavy black curve in each of the two diagrams. Both of these factors are of identical quantity in each of the two diagrams.

The white area which is marked "Kilowatt-hours Available During Limited Periods" is also of identical magnitude, though of different shape, in each diagram. This area represents the additional energy output which would be secured by running the generators, which are now used to carry present loads, for more hours per day.

Such result is only possible, of course, if, first, present customer loads and operations can be carried on for more hours per day (as by going to two or three shifts); or if, second, new loads can be

operated solely in the hours—daily, weekly or seasonally—in which present loads are idle and so not presently using the electric capacity which supplies them when they are operating.

The possibilities in such direction, namely, added electric *energy* output from presently *used* generating capacity, represent the second basic field touched upon in the 23-company survey, and the second fundamental aspect of the plan herein proposed.

As to such second phase of the proposed plan, thought has been given to possible practical means of increasing energy output by arranging for more hours of use per day through the improvement of operating load factors that will surely be made possible by the interconnection of all possible generating agencies and by the coordination of manufacturing and other energy-use schedules.

Productive utilization of all such presently installed generating facilities—*both* in utility systems and in the heretofore isolated industrial and municipal plants now proposed to be interconnected therewith—will naturally require certain wise, but practical and practicable, adjustments.

Appropriate changes will have to be made in each local industrial center concerning production schedules, working hours, seasonal distribution of various kinds of production, and other necessary adaptations to secure the greatest desirable utilization of all installed generating machinery. A vast increase in useful war production would be the inevitable result, and a not unimportant collateral advantage would result from consequent redistribution of present peaks on badly over-crowded local transportation facilities in many places. The Appendix, page 255, captioned "Methods for Increasing System Load Factor," goes further into the possible adjustments which might feasibly be made.

The quantitative possibilities in the service territories of the 23-company survey group have been studied. This was done by tabulating the 1941 outputs and peak loads of each steam plant in such territories, which—whether owned by the utility or by an industrial or municipality—would be part of the proposed fully interconnected systems in those service areas, and which was not already operated as a really base load plant in 1941.

For each such plant the potential additional yearly energy output has then been calculated if it were to be operated at 70 per cent and 85 per cent annual load factor, respectively, as to such plant peak loads. The results may be summarized thus:

Steam Plants of:	*Sum of 1941 Plant Outputs Kilowatt Hours*	*Sum of 1941 Plant Peaks Kilowatts*	*Added Kilowatt-hours of Electric Energy Potentially Available If Yearly Load Factor Were Increased to:* 70%	85%
23 Company Systems	8,006,400,000	1,811,300	2,891,200,000	5,196,600,000
Industrial and Municipal Plants Capable of Interconnection*	1,678,400,000	413,600	862,000,000	1,405,000,000
Totals	9,684,800,000	2,224,900	3,753,200,000	6,601,600,000

* Include steam, oil engine and a few other plants.

Thus, if such available steam plant capacity were to be operated at 85 per cent annual load factor, added energy output of 6,601,600,000 kilowatt-hours would equal 68 per cent gain over 1941 output of the same plants.

Such computations as to quantitative possibilities for increasing yearly energy output from plant capacity now used to carry present plant peak loads, are conservative. They do not allow for added output from hydro plants, or for added output due to coordinated operation of steam and hydro facilities, or for gains due to taking advantage of diversities between plant peak loads, or for many other practical factors. The results of the above summarized computations, therefore, are not, probably, of great intrinsic significance. But they are of the right general order of magnitude and they demonstrate amply the very real importance of taking all possible steps promptly in each system or regional area in the direction indicated.

National Potentialities—The 1941 annual energy output of utility steam central stations in the United States was approximately 106,896,800,000 kilowatt-hours. The output of the corresponding steam stations of the 23-company group was about 8,006,400,000 kilowatt-hours, or 7.5 per cent of the total. As to isolated industrial and municipal plants, it is likely a fair assumption that their proportion nationally is not substantially different from that in the service areas of the sample group of companies. The total 1941 energy output of such group was about 9.8 per cent of the total output for that year for all corresponding systems in the United States.

If national potentialities for *added* energy production by Load Factor Improvement to 85 per cent are indicated with fair accuracy by the data for the 23-company sample group, the yearly added electric output for the United States as a whole, from utility and industrial and municipal plants, would be about 83,300,000,000 kilowatt-hours.

Here again, the figure may or may not be very precise. But it shows potentialities far too great to be neglected or ignored longer in war-time.

Costs and Critical Materials to Interconnect Isolated Plants

A pertinent question is, "What critical materials and what costs would be necessary to interconnect the kind of isolated industrial and municipal plants herein discussed with utility lines or substations?"

In the first place, the kind of equipment required would not include turbines or other rotating machinery which can be made only with materials, machines and skilled labor now so badly needed for shipbuilding and other highest-priority industries.

Amounts of copper required would be relatively small as individual connections would be quite short and of limited capacity. Pole needs would be moderate for the same reasons. Transformers, switches and accessories would be the main manufacturing hurdle but these would be far less critical in proportion to the capacity and energy gained than would be possible under any other program to attain the same end results. And the time element for the plan proposed would be far less than for any other such possible alternative program.

The 23-company preliminary surveys went into the cost and nature of necessary interconnection facilities less fully than into the analysis of capacity to be gained. But, for instance, data for 18 of the companies indicate that the cost to connect some 235,000 kilowatts of presently idle capacity would be roughly $4,510,000. This averages only $19.20 per kilowatt gained.

Data naturally show considerable variations between systems and even between plants in each system. However, as already noted once, no extreme cases were included in the tabulations herein

presented. To get a little more detailed idea of the general problems, a few figures from the survey of one Southern utility company are instructive. For such company:

—27,800 kilowatts of total capacity in industrial and municipal plants can be interconnected with the company system for less than $10 per kilowatt
—12,600 kilowatts of such capacity, currently unused because in excess of capacity needed to carry loads, could be tied in for about $14.50 per kilowatt
—As to materials required, to make the full 27,800 kilowatts of interconnections would take

25,500 KVA of transformers
35 tons of copper wire
400 poles

Some companies in other parts of the country would show sharp variations from such figures. But, generally speaking, it would seem that the bulk of the presently idle capacity in isolated industrial and municipal plants could be put to work at somewhere around 25 per cent of the cost of installing equivalent new capacity.

And the time required to do the job would be from two to six months under pressure of war conditions; rather than from two to four years to build new steam and hydro plant capacity.

Conclusion

Of course, no such analysis as this should close without emphasizing that the possible plan it develops, like any venture into new fields of operation, should not be looked upon as any self-sufficient panacea. All that is suggested here is that the studies which have been made, based on actual field checks as to equipment available in the areas sampled, offer such definite possibilities as to encourage further thought and action in any area where power capacity problems become urgent.

All kinds of practical difficulties may well be met. For instance, perhaps

—The necessary material to interconnect all plants simply might not be obtainable under today's war conditions, even though needs might be quite low compared with the possible gain in capacity or energy.
—Loads may develop in different sections of any region from those where surplus capacity is available for ready use.
—Coordination of the operation of facilities under widely diverse ownerships and interests may introduce problems of negotiation which are insurmountable despite the physical or technical possibilities.
—Any plan which is founded on longer hours of use of available power capacity must rest first on a program for longer hours of use of industrial facilities which would consume the power; and such changes in plant operating schedules of factories and other customers may or may not be feasible due to the many kinds of personal elements involved, again regardless of the purely physical or technical possibilities.
—The time required, either to get materials or to reconcile diverse views of numerous kinds, may be so great that curtailment will be essential in some sections before such reconciliation can be effected.

This study, therefore, is only an attempt to gather, analyze and present facts as to physical and technical possibilities. It suggests a possible program, but does not itself constitute such a program.

However, the "bits and pieces" plan herein described *can* be applied if the necessity is great enough and the will to do it is present, in some degree at least, in any regional territory where a power shortage seems to impend.

The plan need not—and should not—be applied on any national basis. It is adapted to, and depends upon, "doing the best you can with what you have," in each regional power-supply area. That is the best way to get out war production in 1942. Waiting for perfect, new, efficient productive facilities in some later year may well cause this country to "miss the boat."

Adoption of the plan proposed will:

—Make available large amounts of electric power and energy for war production
—Do so with minimum use of critical materials
—Do it fastest
—Release factory facilities and manpower required under any alternative program for immediate use turning out munitions, ships, and such critical items

The plan is flexible. It will take patience. It will require tolerance and skill, especially in negotiations with operators of numerous small isolated generating stations.

But it can be done. It can be achieved quickly through the cooperation of the "know-how" men of the utilities, industrials and municipalities in each local service area. It should be done so that badly needed, but currently idle, electric capacity can be put to work in war production in 1942.

APPENDIX—METHODS FOR INCREASING SYSTEM LOAD FACTOR

Improving the load factor on electric generating plants, in the main, can come only from improving the load factor in the industrial and other energy-using establishments supplied from such generating stations. The possibilities in such direction depend largely upon two factors: first, going to more shifts in industrial factories, mines, etc., and second, disturbing some customary "work habits" in such plants and others. Both may be unpleasant judged by peacetime notions. Both may be indispensable in war.

It is fully realized that lack of necessary industrial raw materials, inadequacy of transportation schedules, shortages of trained labor or supervisory personnel, and many other factors having nothing to do with electric power supply requirements or electric power use possibilities, may be the final factors limiting what can be done. But analyzing only the factors having to do with the ways and means to facilitate best use of all available electric generating capacity, the following methods of increasing system load factor indicate what can be done—wherever and whenever necessity so dictates.

A—Industrial Possibilities

1—Industrial plants not producing necessary war materials

—For those plants now operating 24 hours a day, curtail production during periods of peak demand (daily, weekly and seasonally)
—Substitute fuel-fired for electrically-heated equipment where basically economical
—For those plants not operating 24 hours a day but operating on peak, shift operation to off-peak periods
—Promote installation of own prime movers by customers having process steam uses which make private power production economical
—Shift production to more efficient plants and if necessary pool production facilities in more efficient plant
—Where continuous flow of processed material is not essential, concentrate some operations as to storable intermediate products in off-peak hours

2—Industrial plants producing necessary war materials

—Equalize production throughout 24-hour day
—All plants not on a 24-hour a day basis, arrange their shifts so as to work off-peak
—Those plants on a 24-hour a day basis but with one light shift, operate light shift on peak
—All departments not working 24 hours a day, work only off-peak
—Shift clean-up period and tooling-up period to present peak hours to reduce peak demands
—Any heavy demand machines or furnaces not operated 24 hours a day, utilize only during off-peak periods; if feasible, also concentrate parts of productive process whose output is storable in such off-peak periods
—Make full use of customer refrigeration, water and ice storage—pump at night
—Install demand limitators on equipment such as compressors that can be shut down for short periods to avoid use on peak
—Promote improved power factor
—Keep motors loaded as near rated capacity as possible
—Use substitute fuels for heating processes where practicable

3—New plant locations

—Locate new plants using large blocks of power in territories where system peaks are seasonal and then operate them during off-peak season

(*Continued on page* 284)

Conservation of Linemen's Rubber Protective Equipment

By Roy M. Godwin
Philadelphia Electric Company

THE conservation of basic war materials is recognized by everyone to be essential to the effort now being made by the industries of the nation. The emphasis which has been placed by the government on the conservation of rubber presents to the electric light and power industry the obligation to cooperate with conservation while at the same time safeguarding, without question, the workmen upon whom so vital a responsibility rests for essential war work.

The safe working conditions of operators and maintenance men but more especially of the linemen of the nation's light and power companies are almost completely dependent upon extensive use of rubber gloves, sleeves, blankets, line hose, insulator hoods and like equipment. All of this equipment is designed and the safe practices concerning its use have been developed for the sole purpose of making it safe for experienced, trained men to work on energized lines and equipment, and thus make unnecessary the de-energizing of such facilities for maintenance and repairs. Continuity of service is even more vital today than in former years and every effort is being made to maintain service at a high degree of reliability.

Conservation of Existing Equipment

The electric light and power industry has long recognized certain fundamentals which must be observed with respect to the various items of protective equipment made of rubber if these are to be kept in the perfect condition so necessary to proper functioning as essential devices for safety. These precautions take on new significance today as means by which present stocks of rubber goods may be preserved, and cooperation thus given to the conservation program. Important considerations concerning storage in storerooms, on trucks, and use in stations and in the field, are:

A. Storage place should be cool and dark, removed from close proximity to all sources of heat and any high voltage, and preferably in a location where the air is slightly moist.

The Accident Prevention Committee commends to the attention of the Industry this summary of present practices of some companies concerning the use and repair of linemen's rubber protective equipment.

Care in matters of correct usage, handling, and sorting of such equipment has long been recognized as essential.

Present and anticipated shortages of rubber indicate the desirability of considering at this time repair procedures which in former years were deemed neither economic nor necessary.

B. Protection should be afforded against contact with oil, grease, chemicals, etc., and articles should not be put away wet.

C. Different classes of articles should be stored separately and in a manner to prevent damage by other materials. They should be wiped clean of all dirt before storing.

D. Gloves should not be left turned inside out, nor any rubber protective equipment left folded or in any other condition which places the rubber under stress while in storage.

E. Articles should be handled carefully and should not be thrown into bins or from poles. Injury from spurs, tiewires, and tools should be prevented.

F. Articles should not be left on lines longer than necessary, as the rubber will thus be exposed to corona cutting. *Undue* exposure to direct sunlight should also be avoided.

G. All articles should be thoroughly inspected in the field before use.

H. Proper leather protectors should be worn over rubber gloves and the rubber gloves should always be air-tested by the wearer before use.

Until recently manufacturers of rubber protective equipment and the electric utilities have considered it neither advisable nor economical to use rubber protective equipment that has been repaired. Today, however, the industry is faced with a different situation and the matter of repairing such equipment needs to be considered more critically, as the indications are that such practices may have to be employed as a matter of necessity.

Governmental agencies have so far permitted the manufacturer to produce rubber protective equipment on a month-to-month basis as of the 12-month period, April 1, 1940, to March 31, 1941, but how long this policy will continue in effect no one can predict.

Repairing Rubber Protective Equipment

Recently a questionnaire was sent by the Accident Prevention Committee to 100 utility companies requesting information concerning their practices in repairing rubber protective equipment. These companies were representative of the industry and were of varying sizes. Their operations covered territory from the Gulf of Mexico to and including Canada and from the East Coast to the West Coast.

The following data have been compiled from the answers received and are presented as a summary of present practices in the industry.

Present Practices of Some Utility Companies in Repairing Rubber Protective Equipment

GLOVES are being repaired in the cuff only but at points not less than 4 inches from the crotch between the middle and third fingers, 2 inches between defects and defects no larger than ½-inch tear or ¼-inch hole. *No repairs in the palm, back of hand, thumbs or fingers.*

SLEEVES are being repaired with the limitations of not less than 3 inches between defects, or a defect larger than 1-inch tear or ¼-inch hole.

BLANKETS are being repaired with the limitations of not less than 3 inches between defects, or defect larger than 1½-inch tear or ½-inch hole.

LINE HOSE and INSULATOR HOODS do not lend themselves to repair by ordinary patching methods due

(*Continued on page* 260)

The Theory of Probability Applied to Accidents

By D. C. Stewart
Safety Supervisor, Niagara Hudson System

PROBABILITY, whether called by that name or not, has long been a useful tool in accident prevention. Mass statistics on past accidents, when carefully collected and analyzed, have yielded data by which the most probable sources of future accidents can be predicted. Any program based upon such studies embodies this simple but none the less important application of the principles of probability.

The prevention of accidents is primarily a human problem which will not be solved by a statistical approach alone, but its very complexity demands the fullest use of all tools which will aid in the task. Probability is one of those tools. It gives order and meaning to events or series of events which might otherwise seem haphazard and unrelated. More important, an understanding of its principles enables those responsible for the promotion of accident prevention to be guided more by the underlying probabilities in any situation and less by the occurrence of unusual or spectacular departures from normal expectancy which are more apt to occur where exposures are relatively small.

Probability

A few illustrations will develop a simple conception of probability adequate for the purposes of this study.

The classic example is, of course, the determination of the probability that a head will appear in a single toss of an ordinary coin. If the coin is tossed once, the head will either appear or fail to appear. A single trial, therefore, is unlikely to convince the experimenter that he has obtained the desired probability. If the coin is tossed a number of times, however, he observes that the ratio of the number of times the head appears to the number of tosses approaches ½ as a limit, drawing nearer to this value as the number of tosses increases. Finally he concludes that heads are as likely to appear as to fail to appear, and that the probability of a head appearing on a single throw is therefore ½. The probability that it will fail to appear is also ½.

If p represents probability of a head appearing and q the probability of its failing to appear, then $p + q = ½ + ½ = 1$. In the mathematics of probability unity is the symbol for certainty and 0 the symbol for impossibility.

Investigators in such fields as the determination of human life expectancy or probabilities relating to industrial accidents must of necessity adopt the statistical or empirical approach. The long march of human events "tosses the coin" for them in their respective fields and from comprehensive recorded statistics the desired empirical probabilities can be calculated. If the "coverage" or "exposure" is sufficiently large the calculated probabilities are remarkably stable and decisions based upon them may be made with considerable confidence.

Table 1 illustrates the derivation from available statistics of the probability that a lost time accident in the electric light and power industry will be fatal.

The probability that a lost time accident will be fatal is .028 and the probability that it will be nonfatal is .972 or $p + q = .028 + .972 = 1$.

As mentioned before, these empirically determined probabilities are relatively stable if derived from large exposures but there is nothing inherently permanent about them. The penny tosser might be excused for assuming that his experiment had settled the question once for all, but the calculator of empirical probabilities can make no such assumptions. The National Safety Council statistics show, for example, that more industrial workers sustained disabling injuries per million man hours worked 15 years ago than were injured during the same exposure period last year. The probability that an industrial worker will sustain a disabling injury has, therefore, decreased in the last 15 years.

Figures for all industry should not be applied indiscriminately to any one industry nor should figures for an industry be applied indiscriminately to any one unit in the industry. On one of its posters the National Safety Council states, "It's an actual fact, if you meet with a lost time accident while at work, 1 chance in 90 you'll be killed." Table 1 indicates a corresponding chance of about 1 in 36 for the electric light and power group. Figures from one large utility of this group indicate a chance of about 1 in 50 within that unit.

However, the fact that empirical probabilities have such limitations and that many forces are constantly at work to change them by no means denotes that they are valueless. The amazing growth and success of all branches of insurance is due in large measure to the collection of mass statistics and the application of empirical probabilities determined therefrom to the writing of individual policies. The cause of accident prevention can also be advanced by careful study and application of empirical probabilities.

The Time-Distribution of Accidents

Industrial accidents in general are neither anticipated nor desired and may, therefore, in some degree be classed as

TABLE 1—EDISON ELECTRIC INSTITUTE ACCIDENT PREVENTION COMMITTEE STATISTICS

Year	Lost Time Accidents Per 1000 Employees	Fatalities Per 1000 Employees	Probability That a Lost Time Accident Will Be Fatal
1931	33.7	.97	.029
1932	24.9	.72	.029
1933	21.4	.66	.031
1934	21.1	.64	.030
1935	22.1	.59	.027
1936	26.4	.71	.027
1937	28.8	.76	.026
1938	22.7	.67	.029
1939	20.8	.57	.027
1940	21.0	.57	.027
		Average	.028

random events with respect to time. Random events are subject to a law of probability and form a well defined time pattern. A flood of accidents within a relatively short period of time should always be cause for concern but it does not *necessarily* mean that an accident prevention program is falling down. On the other hand, a dearth of accidents in a like period should occasion no complacency because it does not necessarily mean that prevention measures are effective. Chance and probability have decreed that such patterns should exist.

In Table 2 reported accidents occurring in the year 1939 in a large electrical utility are listed by the number of days in which various given numbers of accidents occurred. To eliminate as far as possible variations in exposure to injury Saturdays, Sundays and holidays were excluded from the tabulation because only a part of the force was at work on those days.

Empirical probabilities were calculated from the observations. The theoretical probabilities were then calculated by Poisson's Law of Distribution. This law states that if a set of events is distributed at random over an interval of time the probability of a given number of events lying in any designated subinterval of time is

$$P = \frac{E^n e^{-E}}{n!}$$

where P is the required probability
E is the expectancy of events within the subinterval of time
n is the number of times that the specified event occurs
n! is the factoral of n. e.g. 3! = $3 \times 2 \times 1$
e = 2.718.....

In this case the total number of accidents over the interval of 255 full working days was 572. The expectance in the subinterval of 1 day was 572/255 = 2.24 accidents.

The agreement between observed and calculated probability is not perfect. This is not surprising when it is considered that the distribution of accidents on the time scale is not entirely at random. There are seasonal variations in reported accidents; also weather conditions, unusually hazardous jobs and many other factors increase or decrease hazards on some days, tending to cause some departure from the randomness assumed by Poisson's Law. The agreement, however, is sufficiently good to indicate that a law was at work, insuring order in the midst of seeming disorder.

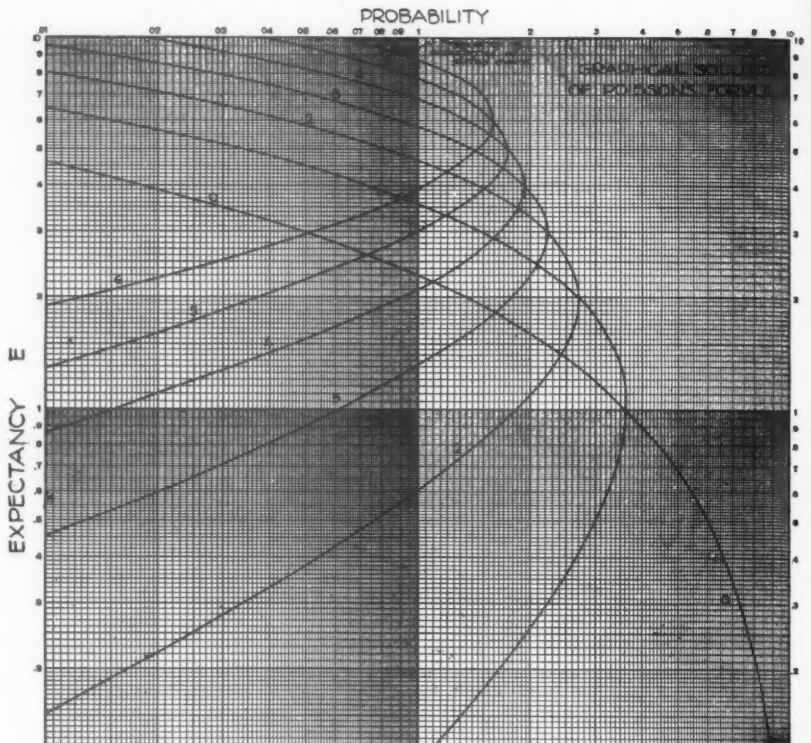

Fig. 1—Graphical Solution of Poisson's Formula.

TABLE 2—OBSERVED AND THEORETICAL DISTRIBUTION OF REPORTED ACCIDENTS OF AN ELECTRIC UTILITY IN 1939

Number of Accidents in a Day	No. of Days Having Given No. of Accidents	Observed Probability (32/255, 63/255 etc.)	Probability by Poisson's Law*
0	32	.125	.106
1	63	.247	.239
2	76	.298	.267
3	45	.176	.199
4	19	.075	.112
5	11	.043	.050
6	5	.020	.019
7	3	.012	.006
8	1	.004	.002

* Figure 1 furnishes a graphical solution for Poisson's formula.

Repeated "Trials"

Allied to the problem just considered is that of finding the probability that an event will occur any specified number of times in a given number of "trials" when the probability of its occurrence in a single "trial" is known.

As an illustration consider the all important question of industrial fatalities. Fatalities are a deplorable human, social and economic loss. Their cost forms a large proportion of the accident bill. They seem to have a habit of appearing singly or in multiple at times when substantial progress seems to have been made in accident prevention or of being conspicuously absent from places where safety is no more than a byword. There is a very human tendency to judge the effectiveness of accident prevention activities by the frequency with which such outstanding events occur and it is important to have some means of estimating underlying probabilities.

What are the probabilities that there will be exactly 0, 1, 2, etc., fatalities in the next 3, 30, 300 or any other stated number of lost time accidents? The expansion of $(p + q)^n$ will answer the

question. The expansion of this binomial is:

$$(p+q)^n = p^n + {}_nC_1\, p^{n-1} q + {}_nC_2\, p^{n-2} q^2 + \ldots\ldots + {}_nC_{n-r}\, p^r q^{n-r} + \ldots\ldots + q^n$$

where n is the number of "trials"
and ${}_nC_1 = n/1$, ${}_nC_2 = n(n-1)/1.2$, etc.

The generalized term ${}_nC_{n-r}\, p^r q^{n-r}$ is the probability that the event will happen exactly r times in n "trials."

The probability that the event will occur *at least* r times in n "trials" is the sum of the terms in the expansion up to and including the term ${}_nC_{n-r}\, p^r q^{n-r}$.

In the electric light and power industry from Table 1 p = .028 and q = .972. For illustrative purposes this binomial is expanded to the third power.

$$(.028 + .972)^3 = .028^3 + 3 \times .028^2 \times .972 + 3 \times .028 \times .972^2 + .972^3$$
$$= .000022 + .00229 + .0794 + .9183$$

In the next 3 lost time accidents the chances are:

.22 in 10,000 that all 3 will be fatal
22.9 in 10,000 that exactly 2 will be fatal
794 in 10,000 that exactly 1 will be fatal
9185 in 10,000 that none will be fatal

The probability that *at least* 1 will be fatal is the sum of the first 3 terms of the expansion. This sum is .0817, a chance of 817 in 10,000.

Calculation of probabilities by the binomial expansion is a tedious process when the number of "trials" is large. Where p is small compared to the number of "trials" Poisson's formula will give results closely approximating those obtained by the binomial expansion, at the same time lightening the labor of calculation enormously.

Table 3 was prepared by use of this formula. It gives the probabilities that there will be 0, 1, 2, 3, 4 or 5 fatalities in the next 25, 50, 100 or 200 lost time accidents if p = .028 and q = .972.

TABLE 3—PROBABILITY OF OCCURENCE OF FATALITIES

No. of Fatalities	Number of Lost Time Accidents 25	50	100	200
0	.497	.247	.061	.004
1	.348	.345	.170	.021
2	.122	.242	.238	.058
3	.028	.113	.223	.108
4	.005	.039	.156	.152
5	.001	.011	.087	.170

This table is largely self-explanatory but an interpretation in the popular language of chance might be of interest. The odds are 2 to 1 that there will be no fatalities in the next 25 lost time accidents as against none in the next 50. Odds are even that there will be exactly 1 fatality in the next 25 lost time accidents as against 1 in the next 50, a rather startling conclusion. The probability that there will be *at least* 1 fatality in the next 25 lost time accidents is (1 — .497) = .503 which represents nearly even odds. The probability that there will *be at least* 1 fatality in the next 50 lost time accidents is (1 — .247) = .753, which represents odds of about 3 to 1.

A Costly Error in Judgment

Some of the foregoing observations may seem little more than the clothing in mathematical language of facts which supervisors and executives recognize to be true almost intuitively. Many may do so but some do not.

The following example of failure to understand these principles was related to the writer by a man who was at one time superintendent of a small electric light and power company employing about 100 persons. In the 10 years that he had held that position the company had had no fatal accidents, and in fact he had heard of none occurring since the formation of the company. They had just completed a hazardous pole removal job from an important street of the small city in which they operated without a single serious injury and were feeling pleased over the accomplishment.

Meanwhile, others had not been so fortunate. During the period in question the experience of other policyholders of their Insurance Company had become worse and premiums were climbing. Several conferences were held to discuss the desirability of continuing the policy. The officers concluded that their record proved they had overcome the hazards of the business, and that to continue the policy would only be paying for the misfortunes of others who had not learned to do their work safely. The policy was discontinued at the end of the year.

In the Summer of the following year 2 men were killed, another was killed in the Fall of that year and in the Spring of the next year another man lost his life, all from electrical contacts.

It would be interesting to analyze in detail the experience of this company, but the necessary data is difficult to obtain since these events happened many years ago. EEI data provides industry figures for the year 1923 which is nearest to that time. If the assumption is made that this company was no better or worse than the industry in lost time accidents, a rough idea of the probabilities may be obtained.

Lost time accidents in the industry in 1923 were 9.7 per 100 employees and fatalities were .17 per 100 employees. From these figures p = .018 and q = .982. The expectancy of lost time accidents for the company over a 10 year period was 97 and over an 18 months period about 15. The probability that they would complete a 10 year period without a fatality was $.982^{97} = .171$, and the probability that they would have 4 fatalities in a period of 18 months was, by Poisson's formula, .00017.

The error in judgment occurred in failing to realize that the chances of completing 10 years without a fatal accident were small (171 in 1000 or about 1 in 6). They "won" during that 10 year period when the odds were 5 to 1 against their doing so. "Retribution," on the other hand, was far more severe than might have been anticipated since the chances of having 4 fatalities in 18 months were only 17 in 100,000 while the chances of completing the 18 months period without any fatalities were $.982^{15} = .761$ or 761 in 1000.

Accidents in Low Exposure Groups

Sometimes the soundness of the basic philosophy of accident prevention seems to be challenged by the course of events as in the following hypothetical case.

Foreman A and Foreman B are running line gangs. Beyond question A's gang works more safely than B's gang, yet at the end of some period when the record is reviewed A is charged with say, 2 serious injuries while B came through without a single serious injury. A's confidence in the worth of accident prevention methods may be shaken and B may reach the easy and (to him) satisfactory conclusion that there isn't as much to this safety business as the boss and the Safety Department would have him believe.

The principle of insufficient exposure is back of such seemingly contradictory experiences, as it was in the case of the small company described above. The theory of probability will throw some light on this problem.

Some studies have been made which indicate that there is a relationship between the number of unsafe acts committed and the number of serious injuries which result. Lacking a better basis, let us assume that the expectancy is 1 serious injury for every 300 unsafe acts. Let us further assume on a purely arbitrary basis that A's gang committed 300 unsafe acts during the period and that B's gang committed 600 unsafe acts during the same period. Then A's expectancy is 1 serious injury and B's expectancy is 2 serious injuries. Apply-

ing Poisson's Law to the two cases the probabilities of serious injuries in the two gangs are:

TABLE 4—PROBABILITIES OF SERIOUS INJURIES

No. of Serious Injuries	Foreman A	Foreman B
0	.368	.135
1	.368	.271
2	.184	.271
3	.061	.180
4	.015	.090

The occurrence of serious injuries in the 2 gangs are independent events. If the probabilities of occurrence of 2 independent events are known, the probability that both will occur is the product of their respective probabilities.

The probability that A's gang would have exactly 2 serious injuries while B's gang had none was $.184 \times .135 = .0248$. The probability that the situation would be reversed and that B would have exactly 2 serious injuries while A had none was $.271 \times .368 = .0997$. The ratio of these 2 probabilities is 4 to 1. B "won" against substantial odds. The unfortunate part of it all is that if neither A nor B realizes just what happened, the cause of safety may suffer.

If each man could be placed in charge of 100 line gangs, 50 of which worked as A's gang worked and 50 as B's gang worked, the accidents resulting from the increased exposure would be almost certain to demonstrate to them that there is adherence to the underlying probabilities, even though some individual gangs in each of the two groups duplicated the experience described above.

Incidentally, this analysis holds out little hope for those brave souls who still pursue the search for some just formula which will name the winners of safety contests where the exposures of the contesting groups are small or unequal. If the frequencies of commission of unsafe acts or exposure to unsafe mechanical conditions could be determined and those acts or exposures could be weighted according to their probabilities of producing varying severities of injuries, there might be some hope. Obviously, such a rating scheme is impractical.

Conclusions

Individuals tend to evaluate safety measures in terms of their experience or that of their immediate working group. Moreover, unless favorable habit patterns have been formed as a result of the individual's own experience, his present action may indicate clearly that time has dulled the power of experience to influence action.

The laws of chance are such that even the working lifetime of an individual or his group may not involve sufficient exposure to bring accident experience in line with underlying probabilities. A lineman who, for example, always wears working gloves when handling rough objects because his hand was once infected from a scratch may sense no inconsistency in working near live conductors without covering them or without wearing his rubber gloves simply because his fellow workmen and he have done so repeatedly with no ill effects. His first practice is sound but anyone who has carefully examined the records would estimate that odds are long on a fatality occurring from the second situation instead of the first.

Supervisors charged with responsibility for accident prevention have an opportunity and a duty to determine underlying probabilities from study of accidents occurring in larger exposures, and to plan a program based upon the relative importance of those probabilities. Such a program rests, at least, upon a solid foundation.

Beyond that, progress will depend upon the wise selection and effective employment of methods best calculated to mold the attitudes and convictions of men toward accident prevention so that they will pursue a favorable course of action in harmony with underlying probabilities.

Conservation of Rubber Protective Equipment

(*Continued from page 256*)

to thickness and shape. It is possible to repair spur-cut, snagged, or rope-burned insulator hoods with the use of manufacturer's equipment with which the hoods were originally molded, providing the hoods are reasonably new and not badly distorted.

All information regarding repair of this equipment is based upon the assumption that the rubber is in good condition and live rubber. Almost all companies that repair this equipment report that the hot patch method is used. A few companies reported repairing this equipment by the cold patch method. Caution should be exercised when using cold patches, as experience has shown that these patches have a tendency to tear off. Articles so repaired should be inspected frequently by those responsible for their use in the field.

Rubber which has been torn has a tendency to tear further; therefore, in order to stop further tearing, some companies think it a good practice to punch a small hole at each end of the tear before starting the repairs. Ragged cuts should also be trimmed to smooth edges before starting repairs.

Manufacturers advise that the most satisfactory method of repairing these articles is by the hot vulcanized method, using the "Shaler" type patch *and patching on both sides of the defect.* They direct attention to the necessity for all repair work being properly done with a careful determination of the number and relative location of patches. To obtain the best results, the area to be patched should be carefully prepared and the patch applied in accordance with the instructions furnished by the manufacturers of the patching material. If the defect creates a void, this portion should be filled in with rubber patching material before the patch is vulcanized. An injury to line hose does not entirely destroy its usefulness. The damaged part can be cut out and the remaining good portions reissued for service wherever short lengths are useful.

Inspection and Electrical Testing

After articles have been repaired they should be subjected to a rigid inspection and electrical test in accordance with the testing procedure in effect. However, before the electrical test is applied, the article should be thoroughly flexed in the vicinity of the repair to relieve mechanical stresses.

The following data on *routine inspection and testing* submitted by the majority of companies in answer to our questionnaire should be of interest.

Thirty-day period for routine inspection and electrical test

Gloves and Sleeves
10,000 volts A.C. for 3 minutes

Blankets
10,000-15,000 volts A.C. for 3 minutes

Line Hose and Insulator Hoods
15,000-20,000 volts A.C. for 3 minutes

National Safety Council Safe Practices Pamphlet P.U. 3 (under revision) gives information on the care, inspection, and testing of this equipment. For further and more specific information users should consult the manufacturer of their rubber protective equipment.

It will be of assistance to the Accident Prevention Committee in a further study of this problem if records are kept of the performance of patched units.

Light and Darkness in National Defense

By S. G. Hibben

Director of Applied Lighting, Westinghouse Electric & Manufacturing Company and Chairman, Defense Committee, Illuminating Engineering Society

WHAT can we expect of light or darkness, particularly of the present very popular subject of blackouts? At the outset I think we must analyze these things, and then we will understand more about the operation of the next few months. I am no seer; I am no person of omniscient vision; I am only making intelligent guesses, as you will. But we do have a background of study and experience to justify these guesses.

Of course, we want to know what kind of enemy we can expect. Naturally you would say we are trying to defend ourselves against attack by aircraft, or from bombing. Many of us, however, do not understand just what that kind of attack is expected to be. We know that we are vulnerable not just in this city, not just around the Gulf Coast, but almost anywhere—anywhere at least within a three hundred mile strip along the coast, east, west and south. We are vulnerable not only there but inland as well. Many of our acts of complacency have arisen from the fact that we are not good students of geography. By air miles from Norway to Buffalo is shorter than from Norway to Washington, D. C., and Cleveland is just as vulnerable as are Detroit and Chicago. Many other cities, including the river mouths, can be reached by both aircraft and submarines. We think the enemy has several hundred bombers capable of flying a 3000 mile course from Norway or France to here. They can go 7000 miles —we know that—can bring a 1000 pound load of bombs, dump it and go back.

It will be a great temptation for the enemy to do some particular damage to this country from now on. I cannot officially speak for the War Department, nor do I say anything officially for any branch of the Federal Government, but I have a fairly good idea that we find our own military authorities agreeing that the time for protection and the period of greatest hazard will be during the moonlight nights of the next few months.

Indeed, we are vulnerable! We are vulnerable because these bombers are capable of flying not only the distance we are separated from their land bases, but from the decks of airplane carriers. True, a heavy bomber cannot operate from the deck of a carrier, but light ones can, and heavy ones can come to us from many land bases. These ships may fly at altitudes of five miles, 30,000 feet more or less. Some height of 20,000 feet or more to get above ground defense artillery would be an objective. Our own bombers are being designed to fly at higher altitudes than that. And they will come fast. They will come at 300 miles an hour or faster. We are designing our own ships to better that speed and that altitude. At that speed—five miles a minute—remember you are traveling very fast. And that is a height from which you see not just the tops of roofs of a city. You see a circle fifty, sixty or seventy miles in diameter. If we could understand some of those things a little better, we would understand that just as we integrate far-flung production capacities to exchange power, so we must integrate and coordinate these blackout practices.

An enemy may locate a city from fifty or sixty miles off shore, which is only ten minutes away. If we locate him, our own defending craft still have to get high in the air, and the likelihood is that bombs will be dropped in the first few minutes of this token or surprise raid. And this man we are trying to protect ourselves against has a charted course. He is flying by compass, navigation instruments, radio beam or radio broadcasts to guide him. In short, he is not lost, and is aiming for some strategic, valuable and important target.

Of what interest is this to a utility executive? Just this: We possess usable experience. The directors of civilian defense measures cannot be expected to know lighting, and won't have the knowledge that this industry has. Most people so far who have been working on the problem have not had time for research. It is partly our fault as an industry, if we do not "horn in" on the councils and tell them of our knowledge of the subject. We could help guide them, so we won't have our co-workers writing a mandatory rule that you must rush to the basement and pull that main switch; "but be sure to keep the elevators running, and listen to your radio for further instruction."

We plan our protection not only because the enemy flies high and fast and aims at a certain spot, but because he sees what he is going to attack, if normal conditions exist, from fifteen to thirty miles before he comes to that target. The British say after you see aircraft overhead in the sky, it is too late, the damage has been done. Miles away he sees a target and releases a bomb two or three miles short of his target. Which adds to this: you must plan protection and usage of light with a view of concealing any particular target from a flyer at a far distance.

A compromise must be effected between what you might wish to do, and the cost you will pay for that protection. I emphasize that because we have gotten an idea, many of us, that blackouts are cheap. "We pull the switch, save power and money." You do *not* save money. Among protective operations, the most expensive thing you could possibly do is have a *carelessly planned* blackout. It is expensive and dangerous to indiscriminately turn out lights. How many people are we ourselves going to kill while protecting against Hitler's and Hirohito's bombs? How much will it cost us in the crippling of our own war production effort if we carelessly or prematurely turn out factory lights or street lights, or some needed ordinary lighting for living and working purposes. These are fair questions. They suggest engineering answers.

To get a further picture of what kind of blackout we have to plan and why, may I add that in addition to recognizing the intelligence of the enemy aiming at strategic places like large factories, shipyards, and the Panama Canal, in addition to that we must admit these men

see on moonlight nights and they know the geography of this country. There are survey and photographic maps in all the libraries of Europe. These men are not lost. They know where they are. A blackout will not in any sense of the word result in making them completely lost. That is another false opinion I think we can well remove by counseling with our neighbors. A blackout does not bring immunity—not at all. On the darkest night you can fly and still see shores of oceans and rivers. You can fly on a starlit night and follow major railroad tracks. You can follow streams and canals. If you know anything at all about your geography, you can generally locate some reasonably accurate position. Flares help.

You say, "why have a blackout at all —what is the use of it?" It is needed not because it stops the enemy, but because it is a delaying action. Lack of pattern lighting and of land marks delay the location of this particular large factory, or that bridge, or some shipyard long enough so we can get our defending craft in the air. London was bombed repeatedly under conditions of blackout better than we have them, yet St. Paul's dome still stands, and Buckingham Palace and major power stations. Those were valued targets, but the enemy did not have time to fly around and locate them. Yes, a dim-out or on rare occasions, a blackout is needed, but there are many varieties and features that justify our participation in the civilian councils that operate them.

Before this war, we didn't know enough about darkness. We didn't know for instance that one can see two or three times as well under red or yellow as with faint blue light. We didn't know in general that if you had a generous amount of Vitamin A in your system, you could see more in dim light. We didn't know how air pressure at flying altitudes and excitement at times of action might decrease the ability to see. We *did* know, that the human eye could see very well under 10,000 foot candles or 10,000 units of full June sunlight. We knew we could see in the shade pretty well—1000 units of daylight—to play golf, tennis or most any other critical task.

May I say here, we in our industry have been a little timorous. We have been a little inclined in our lighting recommendations, to lean over backwards, perhaps justifiably so, but we didn't have the assurance to go out and shout to industry that they had to have at least 50 foot candles to help win the war. Some of us thought so but didn't say much about it. Who do you suppose really said we had to have this amount of work light to make tanks, planes and guns rapidly on the night shift? The Federal inspectors preached that! Perhaps we are still too timorous because we surely have an interest in utmost production.

In England the mandatory minimum for factory illumination is six foot candles. Their averages are greater. They need to be still greater! In a brightly lighted street you might have one or a little less, and full moonlight is about .02 foot candle. In London, and perhaps in some part of this country, it was found that to completely eliminate the visibility of the terrain, it is necessary to go down to some figure as low as one per cent of moonlight. This is about good average starlight. Our own War Department thinks we can go a little higher than the British maximum, perhaps to 4/10,000 or 6/10,000 foot candle. Somewhere in that range is what we would have to think about in complete blackouts. We could not permit as much as full moonlight because terrain would be fairly visible. The last few months of research have been quite intensive in this starlight zone.

For example, one can't tell *color* under starlight illumination. We study the confusion effects of flashing lights, foveal vision, or the importance of having interceptor pilots dark-adapted.

Then there are some other considerations, before we look at some detailed methods, that are of concern to us. I have the temerity to impose these ideas because I think we ought to be leaders in counseling or telling wardens, police, fire heads, and our own civilian neighbors, how we are going to do this job with the best intelligence. We rushed in it pell mell, fell over our feet, made some honest mistakes, but it is not too late here and now to take this blackout matter seriously as many of us have, and make it part of our specialized job, giving our services voluntarily in the things we might term "beyond the call of duty." Now it won't sell kilowatts or lamp bulbs, but it will sell a service of friendship. More than that, it will be a service of importance to the nation. It may be one of the greatest contributions to winning the war.

Residential areas would probably be targets only by accident, but all peculiar areas can be guides to vital ones. The map patterns that guide the enemy from long distances are the important things, and if we could eliminate the important electric signs, brightly lighted boulevards or thoroughfares, the curving lights that mark a rather individual target area, the black spots of parks or cemeteries, the long repetitive rows of lamps that border an ocean or water front, or the various striking colors of certain illuminations, then we would have done 90 per cent of the job. All the rest, even if it be more than enough, will be done willingly as a matter of helping in the policing and helping the public to share in this job in proper spirit.

We may have a hard time differentiating between what is dangerous and what is permissible light, and we have to begin by turning off most of the lights and from that point work back to a compromise type of blackout which still affords some lighting, plus protection. The carrying on of business and factory operations are vastly important. If we were to follow some of the first types of blackouts, Hitler wouldn't have to send over any bombs; we would have crippled ourselves enough without any raids. We in this industry ought to know it is expensive to blindly turn off lights. We dare not stop production, nor vital transportation, nor depreciate the eyesight and the morale of the younger citizens.

England admits over 10,000 street fatalities of last year, a large percentage attributed to blackout hazards of unlighted streets. I don't know the exact figures of how many people were killed directly by Hitler's bombs, but I doubt very much if there were vastly more. So blackouts are costly. Taxpayers should know that they are needed, but are not to be a deterrent to the major war effort.

Let us examine some of the devices now used in blackout work. For starlight illumination on some streets, but in accordance with local specifications and according to recent War Department specifications, a rather definite design of street lighting is permissible. It consists of a metal hood, concealing disk, and a little light leaking out around the rim, so when it is used with a lamp of some 10 watts, and hung 15 to 25 feet in the air, 250 feet apart, we have just about starlight street illumination. Why don't we do that here all night as in London? Well, just about three reasons, one of which is vital. If we would do that, and if we could get the power and

metal, and if the WPB would think we should supply lamp bulbs, transformers, switches for all that new work, we would still possess a tool of very little usefulness on regular streets, because it requires nearly 30 minutes to become dark adapted after the real warning. By that time whatever danger there is will be over—we hope. However, should we have long blackouts, then starlight street lighting would be useful.

If we lose Bermuda, or Iceland, or Caribbean bases to our enemy, then the situation may change. We may have a permanent blackout every night. Until that time we don't think we need it, if we arrange to quickly cover factory windows, etc. So the general edict which has gone out from most of the intelligent headquarters, is that up until the time just before actual air raid bombing, and excepting coastal cities and areas, not less but more street lighting is wanted; not less but more industrial lighting is wanted. And we should not cripple production nor stop our necessary war operations by any means or under any hazard. Oh, yes, we can turn out a few floodlights in shipyards or momentarily stop some work, but don't predicate any blackout on stopping production for considerable periods.

Over in Europe and in America we find types of metal cans perforated or with red filters, to produce starlight illumination. These are not "approved" devices. In this country there has been no official approval of anything except vehicle head lamps, certain interior and street lighting units and special bulbs, the latter emitting orange light downward. Why orange light? Anything except blue. Ever since Lord Nelson's time, blue was used in the navy as an indication of battle stations and danger. It means something on ship. We generally reserve blue lamps for shipboard service. But on land—in the early days before we thought we would be in a war—we wrote some booklets and let slip through the idea that a dim blue light was a safe thing to have. Now we know better. It is a blue lamp you see quickest out of the corner of the eye. It attracts attention rather than otherwise. So most of these approved dim lights will be of reddish color, or just white.

Lamps for indoor service may take a form like the 15 watt bulb coated black with a bright spot on the bottom, of perhaps an inch in diameter with maximum brightness of one candlepower.

In rooms not completely shielded or any spaces reasonably protected, if we mount a lamp of that type with a hooded or downward pointing aperture, it might be visible to you and me on the sidewalk and our wardens on the street, but if it is not visible two or three thousand feet in the air, it is all right. That is the evolution of common sense. We used to think if we saw any light in a store, we were entitled to throw a brick through the window and turn it out. That is what happened in the west. Now, when you see a dim fire in a fireplace or a little dim light, don't get all excited because Hitler isn't waiting to swoop on it and drop a bomb in that direction. Now, that is not very likely to happen and a little shielded light may help us mightily. That's one reason why we do not open the service switch.

Some of these ten cent store devices, a little hood with a small 7.5 watt Christmas tree or candelabra lamp, plugged in to the baseboard outlet, are pretty well shielded. Incidentally, around dark work places it is a better idea to have dim lights at the places people walk than a dim overhead light. Any dim overhead light may shine out, whereas a low candlepower light close to the floor is not likely to reflect from machinery. Some of the cases of dimming lamps have been so simple, I hardly dare show to a group of electrical men—the simplicity of putting another lamp in series to dim both, or burning a lamp at half voltage, getting about 7 per cent normal candlepower.

On the subject of automobile headlights—I might spend one moment on this because neighbors are asking questions about what to do with private cars. The army has designed some types of official head lamps that mount on the front of the car. Their chief task always is to keep light away from the road and sky, so the beam will come from the headlamp in a narrow wedge. If and when a generally approved type of headlamp is released, and if it is made available for the public, then it would be put on utility repair cars, doctors and nurses cars, police cars, and other things of that sort that have to drive during raids.

All sorts of ideas are embodied in blackout gadgets. For wardens themselves, all sorts of thing have been suggested. One is a torch or flashlight with a red plastic cylinder. While on the subject of torches, a dry battery type has been developed which burns immersed in water and is a comfort to have on a dark night if floating in a life raft.

We have as another by-product of the blackout a glass filter which is opaque to visible light and yet transmits heat, so if you have a drying process you want to carry on without disclosing a great deal of light to the enemy, this is a good way to do it.

What could be better than the miner's cap lamp outfit? Slip it in your pocket and you have a sturdy light for dangerous times. It will burn all night. Recharge it the next day and it is ready to go again. If you have to do a two-handed job, hook it on your coat. It is gas and shatter-proof.

We are interested in keeping our lights burning as much in the interior as we can. That involves covering windows. We have had material developed of metal foil on sheet plastics which reflects the light in one direction. We can use this at the windows to keep light from going through in both directions. Some of the first ideas were to paint all windows with black paint, or cover with plywood, or metal shutters, and all manner of expensive materials. Now we know cheaper ways. In the first place, don't use black paint anyway. A bomb may break the glass and light will shine through the hole. We need ventilation. Americans being what they are, we will open a window and stick our heads out. If you have to paint a horizontal skylight, coat the outside. Use interior curtains where possible. You don't have to have black material to keep light from going through. You don't have to cover a window with *black* paper. Use cheap craft paper. We have spent a lot of money teaching the virtues of light colors, and the minute a blackout comes, we go back to the funeral parlor practice and insist on putting up black, not stopping to think that just to exclude light is all we need to do. White, pink, yellow won't necessarily transmit light any more than black.

As we evolve better means of meeting the blackout and conquering darkness, we will have a better chance to be the leaders of civilization and advance the gospels of light in all the future years. War spurs our genius. For instance, out of the evolution of reflector buttons and marker lights put on the back of trucks and other places, we have learned to take advantage of the fluorescence of some materials under black light units. We achieve brilliant fluorescence of some

(*Continued on page* 268)

The Scientific Approach in Selecting the Right Man for the Job

By Dr. Morris S. Viteles

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A paper originally presented before the Accident Prevention Committee, EEI.

THE purpose of this paper is to review a few recent advances in the development of scientific methods for the selection of workers. Because of the specific interests of this group, I shall limit myself exclusively to a discussion of what has been done in connection with my work at the Philadelphia Electric Company, although examples could be drawn from other electric utilities (and of course, also from other industries) to illustrate how scientific methods can contribute to the selection of competent and safe workers.

The Nature of the Scientific Approach

The essential feature of the scientific approach in selecting workers is merely the application, to the selection of the human element, of the same rigorous techniques as are applied in the selection of equipment required in the production and distribution of electric power. In choosing such equipment, the engineer starts by analyzing the situation, then writes specifications on the basis of his study, designs the equipment, and proceeds finally to test the finished equipment under operating conditions before it is finally accepted and approved for use. Similar measures must be taken in the development of scientific techniques for use in picking the right worker for the job. The job must be analyzed and specifications written to describe the kind of worker that is needed. Appropriate equipment is then designed to determine whether a man meets the specifications, but this is not finally accepted or approved for use until its effectiveness has been examined under operating conditions.

Tests for the Selection of Electric Substation Operators

The methods employed in the development of improved methods for selecting workers, and the results achieved, can be illustrated by reference to the experience of the Philadelphia Electric Company in the selection of electric substation operators. The management of this system rightly prides itself on the care exercised in the selection of mechanical equipment. Specifications and standards for equipment are extremely high. In addition, periodic testing and a great variety of protective devices are employed to insure the very best performance in so far as the mechanical setup and operation of the system are concerned.

In spite of the perfection of mechanical equipment there was an average of 36 operating errors per year chargeable to the 140 electric substation operators employed on the system, when, in 1927 the speaker undertook an investigation of substation personnel.* These errors it is well to note, were made by operators selected with more than the usual concern exhibited in the selection of workers by electric utilities. There was at the time (as there still is) a well-organized, centralized personnel department which carefully interviewed applicants, reviewed their application blanks, obtained references, and applied other traditional techniques of the employment office in determining fitness for work. Moreover, the applicant was hired as a substation operator and spent approximately one year at work and under training in a substation before he was transferred to the position of electric substation operator and permitted to operate a station. In spite of these precautions an average of 3 charged errors was chalked up each month on the records of the Substation Section.

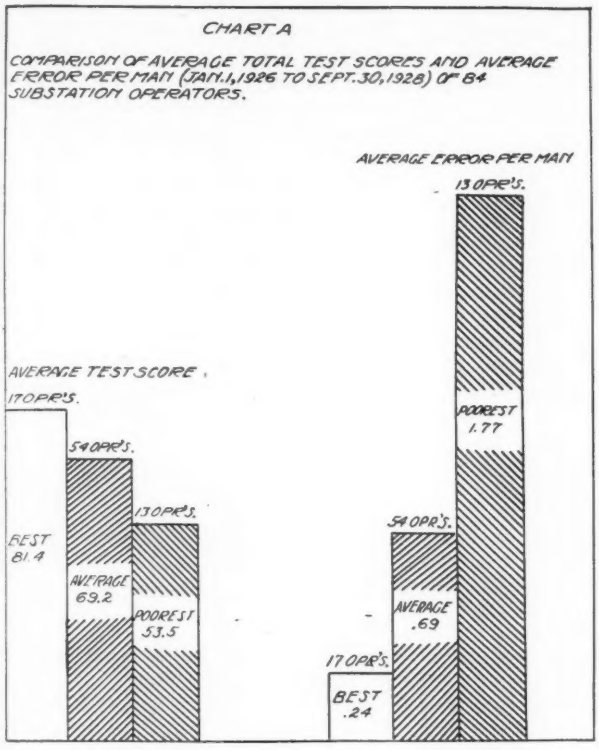
The continued occurrence of operating errors, in spite of the relatively advanced methods of selection, awakened the suspicion that, in part at least, they might be due to the character of the men who had been hired for the job. This suspicion seemed particularly pertinent because, in spite of the similarities of training and experience, certain operators were involved in a number of errors while others, working under exactly the same conditions, managed to proceed year after year without an operating error. As a matter of fact, an analysis showed that in an experimental group of 84 operators who had been in service for not less than 1 and not more than 10 years, the AVERAGE operators averaged 3 times as many errors as the BEST; the POOREST operators averaged 7.5 times as many errors as the BEST; the POOREST operators averaged 2.5 times as many errors as the AVERAGE.

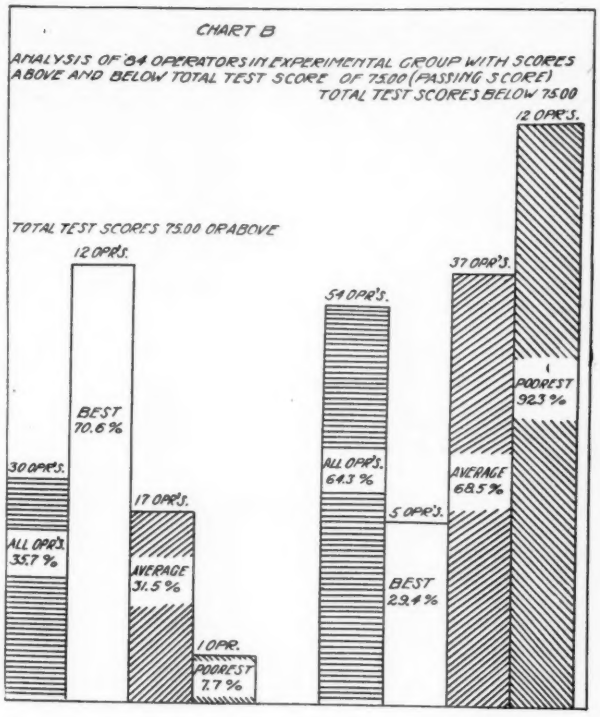
The chief purpose of the study was to develop psychological tests for use in measuring the underlying predisposition to error that appeared to be so conspicuously present in the POOREST group and absent in the BEST group of operators. Tests were selected on the basis of a careful analysis of the job to determine the characteristics of the accurate and safe as contratsed with the inaccurate and unsafe operators.

The tests finally chosen for use in measuring the mental abilities and temperamental traits necessary for safe and accurate switching included 3 series. The tests in Series A and B are used to measure qualities required for accurate switching under normal operating conditions. Series C includes one test, known as the Switching Control Test, for measuring adaptability under emergency conditions. It is essentially a fear-reaction test which allows an opportunity for observing and recording changes in accuracy of response under extremely disturbing conditions of electric flashovers, noise, smoke, etc.

As a preliminary to using these tests

* This investigation was formulated with the cooperation of the supervisory staff of the Station Operating Department, in particular through the interest of N. E. Funk, now Vice-President in charge of Engineering, Philadelphia Electric Company, C. C. Baltzly, General Superintendent, Station Operating Division, and of the late E. O. MacFerran, Superintendent of Substations. In general, the development of improved selection procedures described in this address have involved the active cooperation of operating personnel from the various departments of the Philadelphia Electric Company.





in the selection of substation operators a study was made of the test scores of BEST, AVERAGE, and POOREST operators in the experimental group. The results of this comparison, in so far as Series A and B are concerned, are presented, in part, in Chart A. The average score of the POOREST group is shown to be 27.9 points below that of the BEST group and 15.7 points below that of the AVERAGE group. The average score of the latter group is also 12.2 points below that of the BEST.

A further analysis of test scores showed 75.0 to be the CRITICAL SCORE in distinguishing between satisfactory and unsatisfactory operators, and therefore the one to be used as a minimum "passing score." In Chart B is presented a comparison of substation operators reaching this score with those who fail to do so. The percentage of BEST operators with the passing score is double that of AVERAGE operators and about 10 times that of POOREST operators. It is important to note that only 7.7 per cent of the POOREST operators would have been hired had they been tested prior to employment, whereas 70.6 per cent of the BEST operators would have been employed. This is of particular significance when the difference between the two groups in number of operating errors is recalled. Moreover, as appears on Chart D, the average number of errors of operators who made less than the passing score of 75 proved to be over twice that of men who passed.

Such facts show clearly that scores on Series A and B differentiate substation operators with respect to predisposition to error in switching. These figures, and numerous others of the same kind gathered in the course of the study, demonstrated the desirability of using the tests in determining fitness for substation operation. The tests were put into operaiton in the selection of assistant electric substation operators on April 1, 1928. In addition, substation operators who had not been included in the experimental group were examined and the practice established of reassigning operators in service as well as placing new employees on the basis of test scores. So, for example, operators for newer and bigger stations were chosen largely on the basis of test score. On the same basis, operators with low test scores and unsatisfactory working records have been reassigned to the smaller stations.

The net result has been the marked decrease in operating errors, shown in Chart E which started immediately after the first changes on the basis of test scores which were made and has continued in spite of increasing load on the system.** It is also interesting to note that operators with low test scores who have been retained in the service have added errors to their records at a rate above that of operators with higher test scores.

Relation Between Errors and Accidents

It is to be noted that in this study the emphasis was on the reduction of errors. However, a group such as this, primarily interested in safety, will of course recognize that there is a very evident relationship between errors and accidents. As a matter of fact, a study made some years ago, in Philadelphia Electric Company, showed that those substation operators who were involved in repeated errors tended more frequently to be involved in accidents than operators with none or few errors. In this case, I refer to accidents occurring at times other than when the errors were made. Similar evidence showing an intimate relationship between quality of work and susceptibility to accidents is available from other industries.

Selection of Transmission and Distribution Apprentices

The Philadelphia Electric Company program of developing scientific methods for the selection of employees includes the use of tests in the selection of Transmission and Distribution apprentices. In

** From a report by R. M. Pennypacker, Superintendent, Substation Section, Station Operating Division.

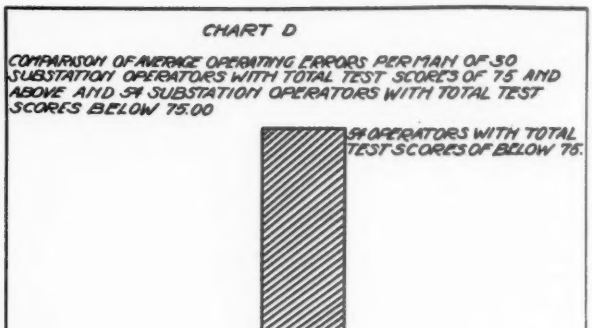


CHART D
COMPARISON OF AVERAGE OPERATING ERRORS PER MAN OF 30 SUBSTATION OPERATORS WITH TOTAL TEST SCORES OF 75 AND ABOVE AND 54 SUBSTATION OPERATORS WITH TOTAL TEST SCORES BELOW 75.00
54 OPERATORS WITH TOTAL TEST SCORES OF BELOW 75.
0.34 ERRORS PER OPR.
30 OPERATORS WITH TOTAL TEST SCORES OF 75.0 OR ABOVE
0.43 ERRORS PER OPR.

1934, a survey was made of the field personnel in the Transmission and Distribution Department (Philadelphia Division) to determine the average age of those employed therein. The survey disclosed the average to be approximately 39 years, the maximum age being 67 and the minimum, 25.*** It was obvious that within a few years the Department would begin to lose the productive service of a large percentage of experienced employees. A study was therefore made to determine the best method of filling such vacancies as they should occur. As a result, it was decided to hire suitable young men and to train them by requiring them, in part, to serve an apprenticeship in each of the major units of the Transmission and Distribution Department.

It was recognized from the start that the success of this program would be dependent in large part upon the quality of the men selected as apprentices. This, incidentally, is true of all training programs. As a matter of fact, many training programs have failed not because of the lack of effort or understanding in planning the program, but because of failure to select in advance those men who could best meet the qualifications necessary for success in the work for which they are being trained. The first step in selecting Transmission and Distribution Apprentices naturally took the form of preparing, in co-operation with the Transmission and Distribution Department a statement of employee requirements, in other words, a job specification.† On the basis of very careful study of the situation, it was agreed that Transmission and Distribution Apprentices should meet the specifications given on Table I. Steps were then taken to select those tests which might best be used in selecting men who would fit these specifications. These include tests of technical comprehension, mental alertness, mechanical ability, perception of spatial relationships, etc.

Experience has proved that these tests are useful in selecting boys who can most quickly learn to become T and D Apprentices. For example, a review of the history of Transmission and Distribution Apprentices (Philadelphia area) shows that those receiving high test ratings made better records on the jobs than those receiving poor test ratings. Twenty-one of these apprentices re-

TABLE I—JOB SPECIFICATION EMPLOYMENT REQUIREMENTS FOR T&D APPRENTICES

	(1) *General*
1. Age: 18 to 24.	Preferred Age: 19 to 22.
2. Height and Weight:	Preferably 5 ft. 8 in. or more in height and above 145 pounds in weight.
3. General Physical:	(1) Normal health and physique and use of senses as indicated by "A" rating on physical examination given by Company physician.
	(2) High endurance under the continued strain of work in awkward and difficult positions and for long periods of outdoor service under all weather conditions.
4. Education:	Not less than 8 grades of elementary school; preferably not more than 4 years' high school.
5. Proficiencies:	Applicants with skill in driving automobile preferred.
	(2) *Aptitudes*
1. Mental Alertness:	Adequate for learnings approved methods of work and meeting the new situations faced by linemen and troublemen at the level of the "average or better" workers in the present force of linemen and troublemen.
2. Motor Ability:	Good muscular control; good finger dexterity; good hand-eye coordination; fast reaction time.
3. Mechanical Intelligence:	Ability to analyze mechanical situations; capacity to develop skill in locating and correcting equipment failures.
4. Attention Span:	Adequate to permit accurate observation under all conditions.

*** From a report by L. G. Witmer in cooperation with J. A. TenBrook, Asst. Supt., Transmission and Distribution Department.

† Prepared in cooperation with J. A. TenBrook, Asst. Supt., Transmission and Distribution Department.

ceived ratings of Fair or above on the psychological tests at the time they were tested. The records of 15 or 71 per cent of these are entirely free from unfavorable comment from the field and the school. Ten apprentices (including those who were tested subsequent to hiring because they were hired before the tests were used), received test ratings of Fair, Fair—, or Poor. The records of only 3, or 30 per cent of the latter are completely free from unsatisfactory comment from the school or field.

A report reviewing the progress of Transmission and Distribution Apprentices tested prior to hiring, prepared by one of the division superintendents states that:

"We have nine of these boys under the leadership of an experienced foreman, one experienced lineman, and one experienced truck driver, and the work which they have been doing is most gratifying and all the boys appear to be exceptional material."

While an effort is made to eliminate the emotionally unstable boys in the selection process, in general, the tests do not measure diligence and other important personality traits. The evaluation of these traits must be left to foremen who are required to size up apprentices working under them with respect to these traits. Periodic rating scales provide a means of obtaining reports by foremen on these traits as well as progress in training. It is also very important to note that the tests make no attempt to measure an applicant's climbing ability. As a matter of fact, it frequently happens that a man who has excellent ability in other respects proves to be poor at climbing, either because he is afraid to climb, or for other reasons. Because of this, very careful attention is paid to a man's reaction to climbing during preliminary training on the pole lot and an effort made to eliminate early in the training period those who show deficiencies in climbing.

Temperament

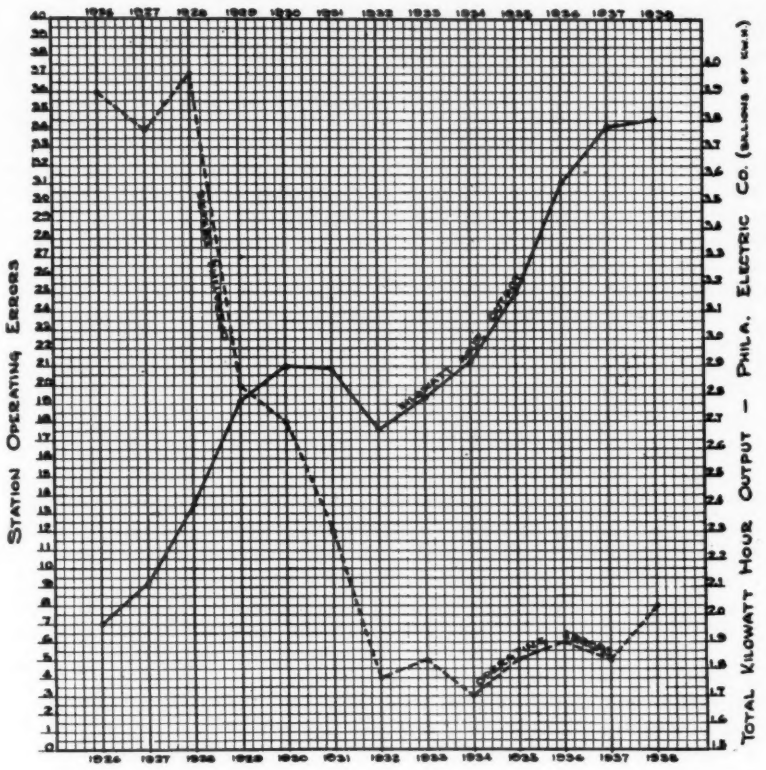
Applicants for the position of T&D Apprentice must be emotionally stable, free from neurotic tendencies, capable of maintaining satisfactory relations in contacts with fellow-workers, customers, etc.

Tests of the type referred to have been used not only in selecting Transmission and Distribution apprentices, but also in selecting apprentice linemen. There is reason to believe that these tests have contributed, together with a systematic training program to reducing considerably the time required to develop good 2nd class linemen.

CHART E.

COMPARISON OF SUBSTATION OPERATING ERRORS AND KILOWATT HOUR OUTPUT

PHILADELPHIA ELECTRIC COMPANY, 1926 TO 1938 INCLUSIVE


STATION OPERATING ERRORS
TOTAL KILOWATT HOUR OUTPUT — PHILA. ELECTRIC CO. (BILLIONS OF KWH.)
1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938

Tests in the Selection of Appliance Servicemen

Our testing program at the Philadelphia Electric Company includes a wide variety of jobs. As a matter of fact, during recent years approximately 50 per cent of new employees are hired partly on the basis of test scores. Among the jobs included in the testing program is that of Appliance Servicemen. The standardization of the tests for Appliance Servicemen was begun in December, 1935.†† In carrying out this experimental study, considerable difficulty was encountered in the matter of reliable and valid criteria, because of the nature of appliance service work, and of the fact that appliance servicemen are more or less specialists on their kinds of appliances. For example, the efficiency of a serviceman working on refrigeration could not be compared with the overall efficiency of a serviceman working on radios, water heaters, etc., on the basis of either production or quality records. As a result, it was necessary to resort to a form of rating, the Paired Comparison Method, in which each appliance serviceman's overall efficiency as a serviceman is compared with all the other servicemen of the experimental group, in checking on the efficiency of the men as a basis for evaluating the usefulness of tests in hiring men to specification.

The Superintendent and Assistant Superintendent of the Appliance Service Division rated the entire experimental group of 89 appliance servicemen on this basis. The ratings of the Superintendent and Assistant Superintendent were ranked in numerical order, combined, and a combined rating thus obtained for each of the 89 servicemen. On the basis of these combined ratings, the experimental group were then divided into 22 BEST servicemen; 45 AVERAGE servicemen; and 22 POOREST servicemen.

Using these combined Paired Comparison Ratings of the Superintendent and the Assistant Superintendent of the Appliance Service Division as the criterion, it was found that a battery of 6 tests, offered the greatest promise in selecting competent appliance servicemen. By means of statistical procedures, the scores on these 6 tests are combined into a Total or composite score. An analysis

†† In cooperation with C. D. Buchholz, General Superintendent, Service Department, and W. C. Pierson, Superintendent, Appliance Service Division.

of the experimental group showed that using a CRITICAL SCORE of 270, 91 per cent of the best servicemen would have been accepted for employment, 82 per cent of the average group, and only 32 per cent of the poorest group. This CRITICAL SCORE of 270 is now used as the passing score in hiring appliance servicemen.

The tests are now used primarily in the selection of apprentices for the Appliance Service Division. The latter are boys who are given a 2 year systematic training program for development in some branch of appliance service work. Experience in the selection of such apprentices has been most favorable. For example, in the last group of 12 apprentices hired, approximately 1 year ago, there is only one boy who has failed to meet the performance standards of the job with respect both to skill in servicing appliances and in meeting the public. Even in the single case, there is still disagreement in reports turned in independently by supervisors as to the character of performance on the job and this group, as others in the past, may turn out to be a 100 per cent group. When the cost of training is considered, it must be recognized that a technique which produces this situation in selecting a man is contributing something that is of dollars-and-cents value to the company.

Other Test Batteries

Reference could be made to many other forms of tests. For example, tests are being used very effectively in the selection of meter readers. There is reason to believe, from reports received from the Customers Accounts Division, that the use of tests in selection has played a part in transforming the very nature of the meter reading job, since men now hired not only do better work as meter readers, but are capable of profiting from the opportunities for advancement to connected load work and collection work which are available in the Customers Accounts Division.

While the selection of clerks, typists, and stenographers may not be of particular interest to an accident prevention group, it may nevertheless be worthwhile to point out that this offers very fertile field for improving performance through improved selection. In the Philadelphia Electric Company, the use of tests in this field has led to an important development in placing promotion from lower levels of clerical and typing work to higher levels of typing and secretarial work on a merit basis. Not only must new employees pass the test, but the choice for advancement is made from those girls who have the highest test ratings, thus assuring the opportunity for promotion to those office employees who are most capable.

Scientific Selection and Industrial Relations

This informal talk is limited largely to a description of various kinds of testing programs employed by Philadelphia Electric Company. I have not attempted to discuss to any great detail the advantages of using improved methods in selection. However, in closing, it should perhaps be pointed out that the use of scientific methods in selection of workers not only produces results in the way of increased efficiency, decreased accidents, and increased individual satisfaction but that it can be employed as an important factor in promoting harmonious cooperation between employers and employees. Experience shows, for example, that discharge of an employee because of "unfitness" constitutes one of the most frequent and troublesome courses of conflict in industry. Management ordinarily finds little sympathy on the part of labor or even of arbitrators for its plea that the worker is incompetent. "That," says labor, "is a matter which should have been settled prior to employment." And whether or not this stand is justified, the issue is one which contributes to misunderstanding and strife.

Under any circumstances, in so far as psychological techniques increase the probability of hiring fully qualified workers, they constitute a major first line of defense against repeated conflict over the discharge of incompetent employees. Hiring qualified workers in the first place is the chief way of decreasing difficulties which are bound to arise when mistakes in initial selection cannot be easily corrected.

Post-War Planning in England

"As things now stand, we have post-war planning committees in every industry, each to some extent ignorant of what the other is doing, with the result that when the time comes to switch from war to peace we shall need a plan to unravel the planning."—*The Electrician (London) June 5, 1942.*

Light and Darkness in National Defense

(*Continued from page* 263)

luminescent plastics useful for making signs. When the war broke in Europe, there was some usage of signs of fluorescent paints—fire stations, shelters, etc. Still they fell short of the things we wanted to do over here. We had, as you remember, an inkling of what we were going to do. When in designing flood lighting for buildings in the good old years when we could go out and sell lighting, we demonstrated how a building looked under normal lighting, daylight, and how it appeared in the dark. The method was with fluorescent pigments.

But we had to go further than that. Luckily one of the things that lead to the new kind of lighting equipment for military services evolved from the old very familiar method of taking a modern fluorescent lamp, turning it inside out or taking the same white coating used on the modern mazda lamp and modifying these powders to slow down their light response. Funny, out of the playthings of yesterday evolve some of the important tools of tomorrow. You know under ordinary light those materials would just be white. Turn off the light, and they continue to shine, because they are phosphorescent. They will be self-luminescent in short periods of time. In other words, charge or "pump them up," set them aside, and they still give off light the rest of the night. All you have to do is expose these materials to light and they continue to glow quite a while. In the dark they would be quite visible and they do not require special irradiation to excite them.

Fluorescent oil cloth has been developed and plastic door knobs, switches, panels of doors, strips to mark aisles in a factory or coated sheets to hang up in the street. Fluorescent strips of tape may guide in a blackout. So we find ways of reducing hazards and improving action under some of these adverse conditions. These are only a few things illustrating exercise of American ingenuity in doing this job as we think it should be done. Loss of life, of action, of production or of a war may occur if we just "turn off the lights."

Utility Advertising in War Time

(American and British Views)

By Davis M. DeBard

Vice-President, Stone & Webster Service Corporation

A Paper Presented at Public Utilities Advertising Association Meeting, New York City, June 23, 1942

IN the preparation of this paper I want to acknowledge the assistance of the advertising departments and their agencies of a number of electric and gas utility companies and associations in England and Scotland, together with those in the United States. The thoughts expressed on British and American advertising, are a composite picture. Thus, any good thoughts which might ensue from this paper, credit should be given to those who have so kindly and generously contributed.

Silence engenders doubt, especially at a time when public opinion is tense. Our nation believes in keeping its people informed and this should go for the electric and gas industries and its customers, just as much as for the government. Remember, this is a peoples war. More women and children have been killed by bombs, bullets and buildings falling than in the history of wars. Our civilian problems in rationing will take place and it is on this point that publicity has a very important part to play in our war effort just getting under way.

I want to quote from a speech delivered by Chester H. Lang, vice-president, General Electric Company, before the Edison Electric Institute meeting in New York:

"I say to you that only one really destructive 'bomb' has been dropped by us into the camp of the enemy. It exploded when the United States entered the war, and when this fact was made known to the peoples of the Axis countries, according to our recently returned newsmen and diplomats. It didn't knock over any troops or tanks. It didn't cause anybody to throw up the sponge. But it made them think—because their leaders had said that this would never happen. This bomb brought down a little plaster in the neat, tight, compartment of the Axis mind. But by itself it will produce no victory for us. Furthermore, our enemies have a secret weapon which haunts me, and that is poison gas—not mustard or phosgene or any of the other pleasant little concoctions—but the poison of our own complacement overconfidence, fed by misinformation and an over-eagerness to march in a victory parade. This is poison because it can knock us out for good. It is to be feared because it is so pleasant to take, and every one of us is guilty of inhaling it at every opportunity. Too many of our leaders, right now, are manning the ejectors of this dangerous gas."

Advertising must be used to sell our customers and the public that we have work to do, hardships, and heartaches to bear, and sacrifices to make in order to WIN THIS WAR. Business as usual, IS NOT FOR US. Every man, every woman, every organization, every business, must conduct their individual and collective affairs in such a manner as to contribute toward the winning of the war. Gentlemen, it would be folly to stop advertising and publicity when our country needs it so much.

I suggested to one of my close public utility friends, Henry Obermeyer, that he write up ten questions on advertising. These questions to be the backbone of this paper. I made a number of copies of these questions and sent them to England and Scotland, and, also, to a number of my American advertising friends for their answers. I wish it were possible to present all their answers, but doing the next best thing, I will try to give a summary. We must realize that in Great Britain conditions are different and restrictions are greater than with us at the present time. However, manufacturing, distribution and sales in the United States is following closely the curve of manufacturing, distribution and sales in England, with some 12 to 18 months lag. In other words, England started in 1938, after Munich, on priorities; changing over from peacetime to war production; the restrictions of peacetime production; taxes; the control of critical materials and supplies; etc. We started in 1939. This had been true up to December 7, when we accelerated, and are now following much closer the English restrictions. Today in England there is very strict control of pulp and paper. The English newspapers are mere skeletons to what they were prewar, and advertising by any company is limited.

No doubt a great deal of advertising will be needed if the proposed English fuel rationing order goes into effect. It is planned to limit each individual to 840 lbs. of coal per year to be used either as coal, as coke, as electricity, as gas, or as oil. The equivalent ratios are given as 1-cwt (112 lbs.) of coal equals 5-therms of gas, or 100-kilowatt hours, or 2-gallons of oil. Such a reduction would save ten million tons of coal, or, about one-third of Great Britain's 1941 consumption.

I believe you will find the following questions and answers of interest:

Question No. 1

Is it necessary, desirable, or wise for an electric or gas operating company to abandon its advertising activities during the war period?

English Answer

Public utilities have a duty to go on advertising. In peacetime, by advertising and other methods, utilities kept their customers advised of advances of applied science and how they could benefit by such advances. *In wartime,* utilities, through advertising and other means, must help their customers to adapt themselves to the social revolutions which total war imposes.

The long term interests of utilities can be served by using such advertising facilities as remain to assist government in carrying out steps relating to fuel economy, food economy and so forth.

It is generally agreed that advertising, not in some measure educational, informative, directional, or useful to the public and the war effort, is open to criticism.

American Answer

Electric and gas utilities, because of their vital public services and their franchises, have an obligation to interpret themselves to their customers at all times. Remember, the public forgets the business when the business forgets the public. This necessity during a period of war is even more important than

under peacetime conditions. The rendition of an uninterrupted efficient utility service is essential to the successful prosecution of the war effort.

Question No. 2

Is it desirable for such a company to maintain its advertising facilities to a normal extent; if not, which should be given up and which retained?

English Answer

It is not desirable for a public utility to attempt to maintain the normal volume and variety of its advertising activities. The question of which form of advertising should be given up and which retained is governed mainly by supplies and materials available. For example, it would be next to impossible today for any company to attempt large-scale window displays, unless it could definitely prove to the Paper Control that the public interest was being served. The same would be true of poster advertising and distribution of brochures, leaflets, etc.

American Answer

A state of war subjects all industries to abnormal conditions and automatically rules out normal advertising procedure. Priorities and other restrictions automatically rule out certain kinds of advertising. The advertising which should be retained and perhaps increased over what it was during normal conditions is that devoted to winning the war effort and maintaining the morale of the customers served by the utility.

Question No. 3

To what extent, and in what form, should promotional load building or merchandising advertising be continued?

English Answer

In total war you have no choice; merchandising policy, like any other policy, is dictated by government decisions on industrial priorities.

Money should not be spent in wartime in endeavoring to promote load or sales of non-essential appliances. To attempt it would be to go against public opinion and public policy, indeed, in many instances against possibility. In present circumstances in England, at least such a policy has no place.

American Answer

Prestige-building advertising in behalf of gas and electric service should be maintained. The investment previously made in trade-marks and dealer sales allies should be protected. The many inherent special advantages of gas and electric service should continue to be exploited, but no special effort to sell appliances or secure new load should be made. Industrial appliances necessary to the war effort must be presented by advertising.

It is interesting to note that the British technical press has not been severely curtailed. In the United States a recent Army and Navy decision allows advertising costs in the technical press to be considered as operating expense on Army and Navy contracts. This is actually subsidy to the technical press of the United States due to the acceptance by the government of its importance to the successful prosecution of the war.

Question No. 4

What, if any, are the special opportunities for institutional advertising?

English Answer

Institutional advertising can be effective only when it is skillfully tied up with the news—that is, when the industry's war activities are dramatically presented in topical relation to the war news. The extent to which institutional advertising can be used depends on whether advertising is rationed or not. In England, for all practical purposes, advertising is severely rationed. The only utility that has made wide use of institutional advertising is the railways, which have used striking posters with the dual purpose of (1) showing the importance of rail transport for winning of the war, and, (2) discouraging unnecessary travel.

There may be opportunities for institutional advertising. One of these might be the importance to the war effort of the by-products of carbonization. Another might be the elaborate precautions taken by utilities against air raid damage and fire in order to assure uninterrupted supply.

American Answer

In times of national stress, institutional advertising comes into its own in many ways too numerous to mention. Here are a few relating specifically to such advertising by utility companies: The adoption of so-called service advertising in which copy points out ways and means of getting the most out of the dollar spent for gas or electric service; economy cooking hints; support of the government's national nutrition program; interpretation of priorities and other orders so customers may understand restrictions imposed on the utility companies; offsetting popular misconceptions of official orders relating to air raid precautions, blackouts, dimouts, rationing of gas and electricity, priorities on equipment, etc., which adversely affect the company's interests as well as that of its customers—in other words not all institutional advertising needs to be of an eleemosynary character; interpreting the community's outstanding contributions to the war effort; copy supporting local patriotic drives for the Red Cross, USO, War Savings Bonds and Stamps, and other national and community projects, especially local civilian defense organizations; and copy emphasizing the fact that the gas and electric utilities consider the winning of the war their first and foremost duty.

Question No. 5

What specialized functions of advertising should be developed relating to the war effort?

English Answer

The educative function of advertising. Instead of stimulating the desire for new things, you have to teach people how to make the best of what they now have. By so doing you help the war effort and keep your customers' good will.

American Answer

Utilities are just as eager as ever to discuss with individual customers the problems arising from war conditions, that directly or indirectly affect them and to endeavor to work out the best possible solution, consistent with total war effort. Proper care and use of appliances as well as proper maintenance must be stressed so that the life of the equipment may be prolonged and the utility service not wasted. It is essential to the post-war utility industry that the customer be fully informed during the war period of what the utility is doing and why.

Question No. 6

How, and to what degree, can reasonable advertising expenditures during the war be justified from the standpoint of stockholders, public service commissions, and the general public?

English Answer

I am a gas stockholder. As such, I welcome all gas advertising that really helps the customer to cope with war conditions, and I know that housewives are grateful for all the help they are given on fuel and food economy by their gas undertakings, and I believe that the good will thus engendered will be useful after the war. Equally, as a stockholder, I

would resent anything in the nature of purely "prestige" advertising as a waste of my money. In England the revenue authorities recognize that a reasonable expenditure on advertising to maintain good will is allowable against taxation.

All advertising in wartime, unless very carefully aimed, is vulnerable to criticism. But, of course, from the standpoint of stockholders the question of the protection of the investment is vital. In general, we feel that advertising expenditure can only be justified when some public purpose as distinct from a sectional interest is thereby served.

American Answer

Utility advertising, the character of which is of a prestige-building nature in full and complete support of the Government's all-out war effort, can easily be justified. Any advertising which attempts to place the company's special interests over those of the nation can be classed as reactionary. We are warned against saying too much, but let's be sure we say enough.

Question No. 7

What recommendations can you make to management with respect to the most effective use of (a) advertising media; (b) advertising departmental facilities; (c) advertising personnel in fulfilling the company's wartime obligations to the community which it serves?

English Answer

In this country the choice of media has been largely dictated by supplies of material. Careful watch must be kept on changing values of different media brought about by air raids, shifting populations, etc. Prewar facts are dead.

The most effective use of advertising media is made by avoiding generalizations and coming down to brass tacks as quickly as possible. For example, there is no tangible result to be obtained from an advertisement "Use Less Electricity," when supporting a Fuel Economy Drive, but if instead we tell the public, "Have Breakfast in the Kitchen and Save an Electric Fire," there is something which can be acted on without discomfort and with a real result in Fuel Economy.

It may be that in many cases the whole of an advertising department may have to go to other work and the advertising work be carried on as a part time function by some other executive. This question is inter-related with the employment of advertising agents as distinct from carrying out the whole of advertising as a function of management and certainly the former seems to be the most desirable under present conditions.

American Answer

(A) Every advertising dollar appropriated should be expected to secure a dollar's worth of value in a period of strictest economy.

(B) The facilities of the advertising department should at all times be kept adequate to the demands made on that department.

(C) Personnel of the department should be kept intact so far as it is possible.

Question No. 8

If advertising of a public utility has been customarily carried on directly or indirectly under supervision of the sales department, should this relation be maintained under the present conditions?

English Answer

The sales department is justified in regarding all that is done now as a jumping-off point for post war activities. It should, therefore, continue to have a directing voice in advertising.

The correct action on this point depends largely on the previous organization and the personnel available during wartime.

American Answer

Where the advertising department is now under the direction of the sales department, such relationship should not be disturbed during the war. It would be highly preferable, during a period of emergency, to have the advertising manager report to the executive officer of the utility other than the sales manager, but the danger involved in doing this is that the entire past procedure would be upset. Any realignment of advertising personnel procedure during a time when everything else is topsy-turvy should be avoided.

Question No. 9

What type of media, among the following, do you regard as most essential for wartime advertising in the utility industry; and can you suggest an appropriate specific use for each medium?

(a) Newspapers
(b) Radio
(c) Bill Enclosures
(d) Direct Mail
(e) Posters
(f) Displays
(g) Motion Pictures

English Answer

In order of importance:

1. Newspaper;
   Greatly restricted, most papers allow 5½ x 2 columns as maximum size.
2. Posters;
   Small size for use on company's vehicles and premises. Posters can only be printed on the back of old posters beyond double-crown size.
3. Displays;
   (Designed so as to use little material and man power.) It is very difficult to get material except for Government work.
4. Bill Enclosures;
   Still possible on a very limited scale.
5. Direct Mail;
   Still possible on a very limited scale.
6. Motion Pictures;
   It is common for an industry to bear the cost of a film which it presents to the Government for use at its discretion. The subject of such films is normally one in which both the Government and the industry showing it are interested.
7. Radio;
   Non-existent.

American Answer

(a) Newspapers
(b) Bill Enclosures

Economical coverage is the first consideration. Any form of advertising which cannot justify itself from this point of view will tend to bring on the utility criticism of customers who will claim that money is being spent recklessly.

Question No. 10

What in your opinion would be the effect on a public utility company of cessation or drastic curtailment of regular advertising for the duration of the war?

English Answer

The answer here must depend upon circumstances. The cessation or drastic cut of regular advertising will certainly be much less serious for a public utility than for a branded article. The point to be borne in mind is that a truce between competitive fuel industries during the war in England does not necessarily mean that they will occupy the same relative positions in public estimation at the end of the war as those which they occupied at the beginning. Because a public utility company usually holds a monopoly, the public tendency is to assume that the company is exploiting that

monopoly at the expense of the public. An individual when dealing with a concern feels rather small and often his only contact is a rather peremptory demand for payment and threatening notice that unless he pays, his supply will be cut and he will have to pay something extra to have it re-connected. All this means that the utility should, at all times, try to break down the distance between supplier and consumer and make the customer feel that he, as an individual, matters and is important. If this is vital in peacetime, it is of even greater importance in wartime, and the utility should continue to improve through its advertising the relations it has with its customers.

A cessation or drastic curtailment of regular advertising for the duration of the war would undoubtedly mean that the utility lost track with its public.

American Answer

Cessation of utility advertising for the duration of the war would be a deliberate sabotage of the investment built up during normal times. It can no more be stopped than a person can stop breathing and expect to survive. Any utility company which crawls into its shell and ceases to interpret itself to the public during a period of war is inviting the inevitable—serious impairment of prestige, political attack and all the other ills associated with a policy of silence. Recent published data indicate that companies which dropped advertising in 1914-1918, suffered severely in the post-war period and some nationally known companies passed out of existence.

The public utility has the responsibility not only to its stockholders, but to its employees, its customers, and the entire national economy as well. This responsibility necessitates that it so conduct its advertising activities during the war that it will survive the peace.

* * * *

In closing, I want to repeat that advertising is not out but, on the contrary, is face to face with the biggest and the most important job of all time; that of selling this war to the people of the democracies of the world.

Advertising that incites non-essential buying and increases consumption is not in good taste, but advertising used as an educational force so that it will mold public opinion and guide people to a greater war effort is the need of the hour.

There is no question that the system of free enterprise, commonly known as the capitalistic system, must be given full credit for the tremendous productive accomplishments of this war period. It would be a mistake and a lack of patriotism, if the representatives of this system, of which the utility is a part, did not keep the public fully informed as to their contribution to this war effort.

Business and Bureaucracy—A British Observation

From the Electrician (London) July 3, 1942

WRITING about "The Business Bloke" in "Truth," Sir Ernest Benn claims that the ideal business man is the fellow who knows his job and sticks to it, for there is generally much more in the job than can be learnt in a single lifetime. The most stupid of common errors is that which supposes that because a man has succeeded as an engineer he will therefore make a success in, say, the Board of Trade. The complementary notion that a long career in the Civil Service is a qualification for a well paid position in business is constantly refuted by practical experience, but as there is no practical test by which to decide whether anybody is or is not a success in the Board of Trade, the demand for business men in government still arises from time to time.

Two Different Worlds

The bureaucrat and the business man are from two separate worlds. The former works behind the force of law; it is not his business to consider his customer; he has merely to issue the form, and should the details fail to be forthcoming within the seven or twenty-eight days prescribed by the Act, to follow it up with a summons. The latter lives by the favor of his customer, and, if he would succeed, every moment of his waking hours must be devoted to the study of better ways to serving and thus winning further favor. The two worlds are as poles apart and the inhabitant of one can be nothing but a nuisance in the other. The bureaucrat works for force; he imposes his pleasure upon his victim; he enjoys security firmly founded upon the power of the law, and the might of the State; and the ultimate logical end of all he stands for, is slavery and war. The business man goes bankrupt unless he can win the favor of a public free to take or to leave his proferred service, the logical consequences of his activities being plenty and peace.

When the Boys Come Home

Of the many tragedies of the moment, none is more distressing than the inability of business to withstand bureaucratic murder. As a sample, Sir Ernest mentions the telescoping antics of the Board of Trade by which millions of valuable goodwill have been obliterated, without any justification except, as openly declared by some Ministers, the destruction of the system by which we have lived. Being at war the Government has the right to take all the men, money and premises it requires and does in fact take them. The National interest is in no way served by employing large staffs of amateur theorists to interfere with the freedom of what little is left. When the war is over we shall pay dearly for the absence of employers who have statutory obligations to take their men back but have themselves in the meantime been telescoped away. In due time and season, when these victims can no longer function as they would desire to do, we shall undoubtedly be told that capitalism has failed again.

Misplaced Scorching

There is to Sir Ernest something grim about the way in which some of these "business blokes" do their very best to facilitate their own assassination. Many of them think it an honor to be invited to join a committee to consider the shortest road to suicide. We have heard a good deal about the scorched earth policy in other lands and have admired the spirit which has enabled patriotic people to destroy all they have, rather than let any of it advantage the enemy. But we have heard too little about the scorched earth policy at home, the scorching process being done not by retreating soldiers, but by those who, having sent the soldiers on, have remained behind to destroy the ways and means of life for the maintenance of which the soldiers are fighting.

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EDISON ELECTRIC INSTITUTE
420 Lexington Avenue, New York

McGraw Prize Paper

Design of 33,000 Volt Wood Pole Line

By C. H. Lindell

THE efforts of engineers in the design of lightning proof transmission lines have been mostly directed toward the more important transmission links, the Tower Line.

In 1934, Mr. A. C. Monteith of The Westinghouse Electric and Manufacturing Company published an article, "Transmission Line Design Estimates—Simplified," in which he coordinated insulation, ground resistances and midspan clearance by means of simple graphs. In 1938 in an article, "Simplified Transmission Planning," also by Mr. Monteith, similar curves were plotted and The Cincinnati Gas and Electric Company has used these curves for designing tower lines with gratifying results.

The design of wood pole transmission lines, however, we believe has not been so adequately solved. Other than balancing the structures electrically from an impulse value standpoint, the proper coordination of ground resistances, impulse values and correct location of ground wires has not been definitely ascertained. We believe that the coordination of the above points is more important for a wood pole line than that of a tower line, because it appears that the location of the ground wire on a wood pole line due to the necessity of smaller spacings is more critical than that of the tower line.

The design curves in this paper represent an attempt to determine the correct ground wire location with respect to the conductors that it protects to insure the best possible operation. A method of introducing a ground wire to properly divert lightning strokes on the older constructions not equipped with ground wires, without increasing the height of the poles, is also developed.

Development of Standard 33 Kv Design Curves

Fig. 1 indicates the present 33,000-v construction used by The Cincinnati Gas & Electric Company. On this type of construction we use an average pole of 40 ft in height, with a 66-in bayonet to support the ground wire. Wood braces are used to increase the impulse strength of the structure.

CARL H. LINDELL

Mr. Lindell is the winner of the first John H. McGraw Prize for 1942.

Born in Sweden, Mr. Lindell came to this country at an early age. He started work with The Cincinnati Gas and Electric Company in 1923 as a groundman on transmission line construction.

He attended the University of Cincinnati and continued to work with the Cincinnati Gas and Electric Company as a part-time employee until 1928.

During this period he worked with the Overhead Transmission Maintenance Department. In 1928 he was transferred to design work on customer and distribution transformer stations, and in 1929 was made Design Engineer in charge of design and layout of transmission lines.

In 1939 he was appointed Supervisor of the Right of Way Department.

The primary function of the ground wire as indicated in Fig. 1 is its use as an intercepter of the lightning stroke and the proper discharge of the resulting wave without spillover to a conductor or a flashover from conductor to ground wire.

Assuming that the lightning stroke terminates at the ground wire at one of the pole structures, it is possible to calculate by proper determination of surge impedances the magnitude and components of the voltage waves in the ground wire. These waves would in turn induce electrostatically in the conductors a potential based on the relative coupling factors between conductors and ground wire. The potential difference between the ground wire and the conductor at any point is,

$$P.D. = (1 - K)\,V_p$$

When P.D. = potential Difference
K = coupling factor
V_p = voltage in ground wire at point in question

If the stroke is at the pole structure then this potential difference represents the voltage impressed across the line insulators. The combined impulse value of insulator and crossarm therefore controls the permissible stroke voltage to the ground wire at the pole structure. If the stroke terminates at midspan the same theory applies except that the limit of the permissible stroke is based on the impulse value of the air gap between ground wire and conductor at midspan.

The coupling factor is equal to,

$$K = \frac{\log a/b}{\log 2h/r}$$

When K = coupling factor
r = effective radius
h = height above true ground plane
a = separation between the conductor and ground wire image
b = separation between ground wire and conductor

For ground resistances of 5 and 10 ohms a depth of ground plane of 30 ft was used and for ground resistances of 10 and 20 ohms we used depth of ground plane of 60 ft.

Using as authority certain recent articles in this field, we assume that the effective radius of a conductor carrying a high voltage is greater than its actual physical radius due to corona effects. This effective radius is a function of the voltage and is expressed by the equation,

$$E = 175.3\, a \log \frac{2h}{a} \text{ kilovolts}$$

Where a = effective radius of the space charge
h = height above the ground plane

With our standard configuration as a

basis, maintaining a 4 ft spacing between the top arm and the bottom arm, the permissible voltage to the ground wire before flashover of the lower phase occurs, was calculated for variations of ground wire of X plus 4 ft above the bottom phase. This permissible voltage at the ground wire is plotted for the various heights of ground wire above the top phase on Fig. 2 which represents the 5 ohm design curve. From probability curves (based on an isoceraunic level of 50) the resulting outages per 100 miles of line per year for the calculated protection levels were also plotted against the height of the ground wire above the top conductor.

This outage curve now indicates the probable number of outages per 100 mi per yr due to strokes to the ground wire depending on X, the distance of ground wire above top conductor. This curve is based on 100 per cent shielding of the ground wire against direct stroke to any conductor. It can be seen readily, however, that as the height of the ground wire is varied above the conductor, that a point would be reached at which the top conductors are no longer protected against direct stroke and outages from this source will result. Figs. 3, 4 and 5 give similar results for 10, 20 and 30 ohm ground resistances.

The problem of plotting a curve which would indicate the number of outages per 100 mi per yr due solely to direct stroke, assuming that regardless of the intensity of this stroke, there would be adequate insulation to prevent a back flash at the conductor, was not easily approached. In an article on "Shielding of Transmission Lines" by C. F. Wagner, J. D. McCann and G. L. MacClane, Jr., the authors through laboratory tests disclose some very interesting points on shielding of transmission lines. This article indicates the many factors influencing direct stroke and the difficulty of obtaining definite information. We have taken the data obtained in this article and used it as a basis for obtaining our outage curve resulting from direct strokes to improperly shielded conductors as follows.

On Fig. 6 we plotted curves which indicate the percentage of strokes that would strike the conductor at various protective angles for various ratios of y, the vertical height of ground wire above the conductor. to h, the height of ground wire above the ground plane. These curves are based on a ratio of cloud height to ground wire height of five due to the presence of wind during lightning storms and the fact that the effective height of the ground wire above ground is usually greater than that at the pole.

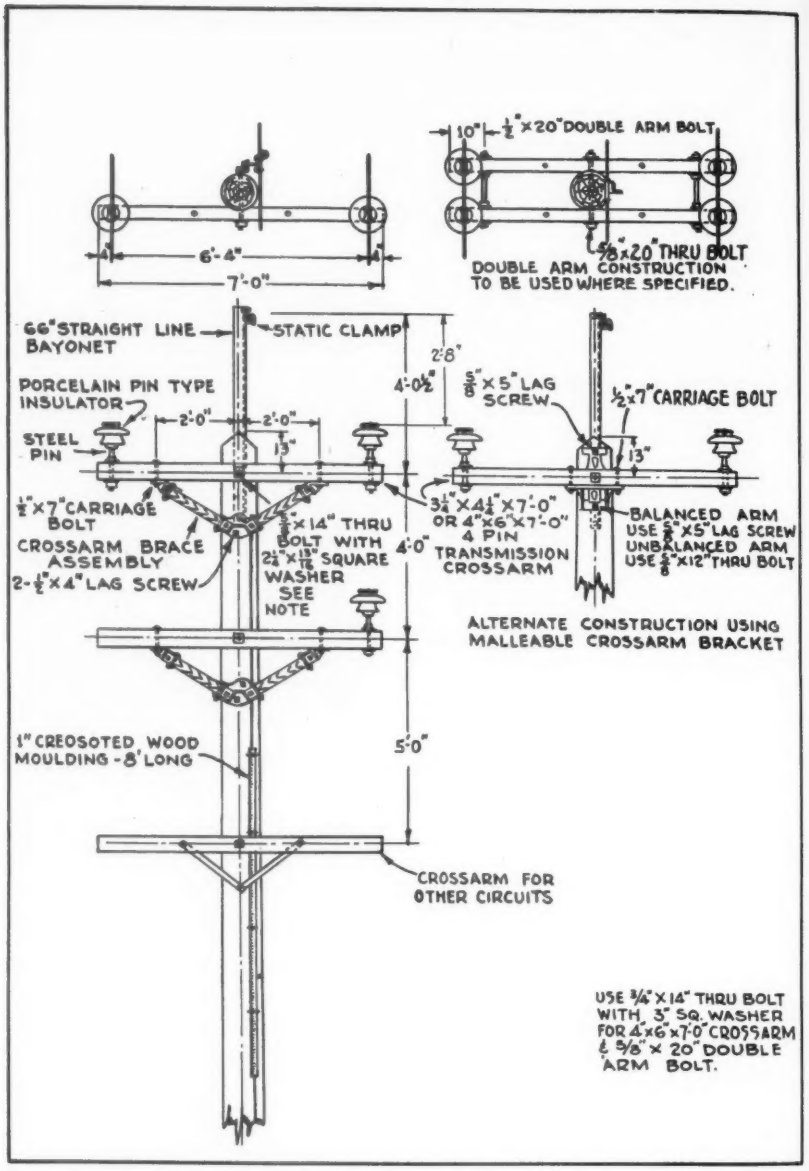

Fig. 1—33,000 Volt Overhead Construction

On Fig. 7 we have set up the characteristics of our 33-kv construction. The first column indicates various heights of the ground wire above the top conductor. The next two columns list ratios of y/h and the protection angle for our standard 33-kv construction for the height of ground wires indicated. Following this is listed the percentages of strokes to conductor which were taken from Fig. 6. To properly apply the percentage of the strokes to conductor, we investigated our outage records for 33-kv lines which are built on ridge pin construction having no ground wire, and thus affording no protection to direct stroke and found that the average outages per 100 mi per yr for 11 operating yrs of 82 mi of construction was 15.8. We, therefore, assume that this represents the fair probability of direct strokes to lines of the height and character of the line under question for our territory. By applying the percentages of strokes to the conductors obtained from Fig. 6 to the figure of 15.8 strokes per 100 mi per yr, we are able to compute the total outages per 100 mi yer yr

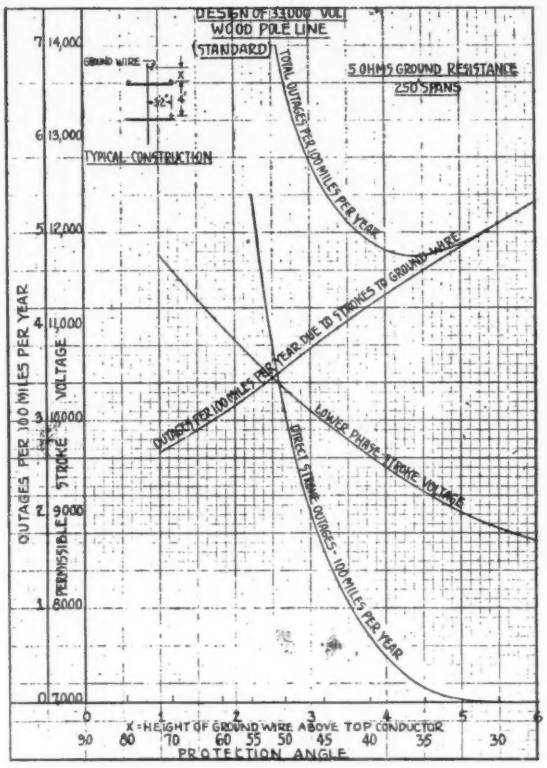
DESIGN OF 33,000 VOLT WOOD POLE LINE
(STANDARD)
5 OHMS GROUND RESISTANCE
250' SPANS
GROUND WIRE
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
LOWER PHASE - STROKE VOLTAGE
DIRECT STROKE OUTAGES - 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 2

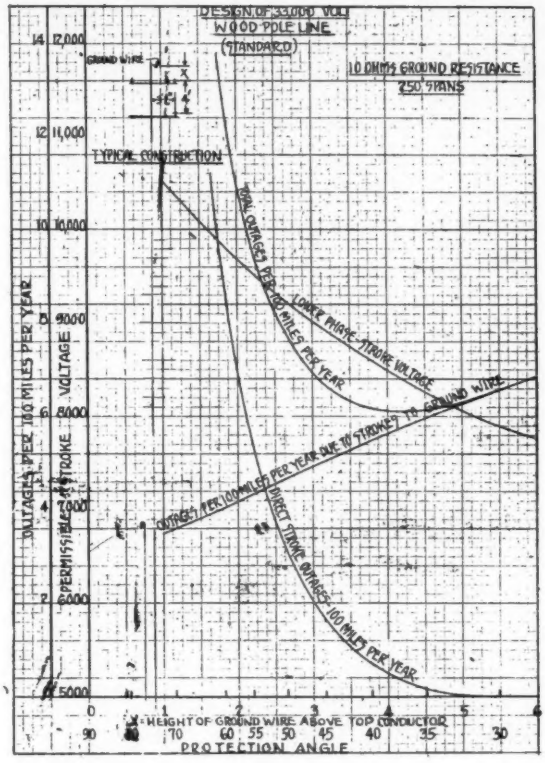
DESIGN OF 33,000 VOLT WOOD POLE LINE
(STANDARD)
10 OHMS GROUND RESISTANCE
250' SPANS
GROUND WIRE
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
LOWER PHASE - STROKE VOLTAGE
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
DIRECT STROKE OUTAGES - 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 3

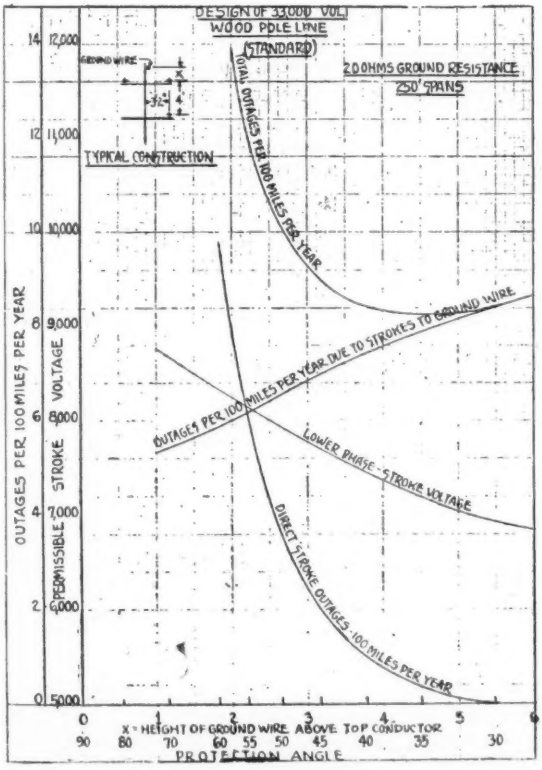
DESIGN OF 33,000 VOLT WOOD POLE LINE
(STANDARD)
20 OHMS GROUND RESISTANCE
250' SPANS
GROUND WIRE
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
LOWER PHASE - STROKE VOLTAGE
DIRECT STROKE OUTAGES - 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 4

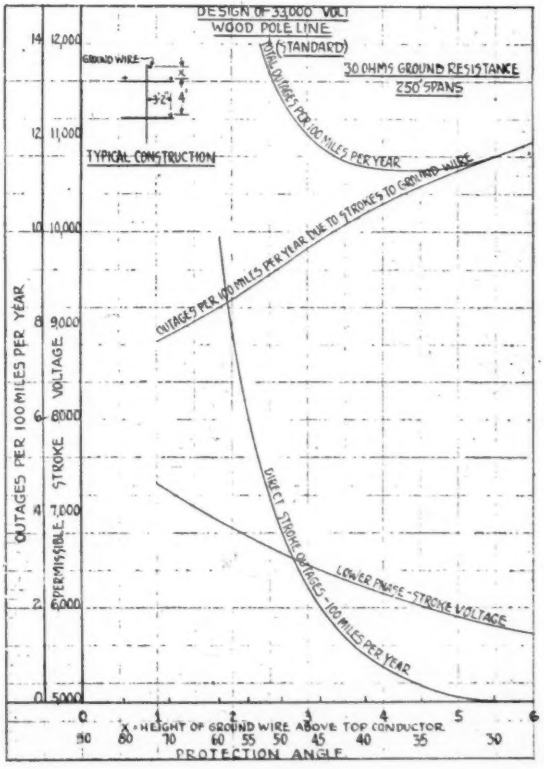
DESIGN OF 33,000 VOLT WOOD POLE LINE
(STANDARD)
30 OHMS GROUND RESISTANCE
250' SPANS
GROUND WIRE
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
LOWER PHASE - STROKE VOLTAGE
DIRECT STROKE OUTAGES - 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 5

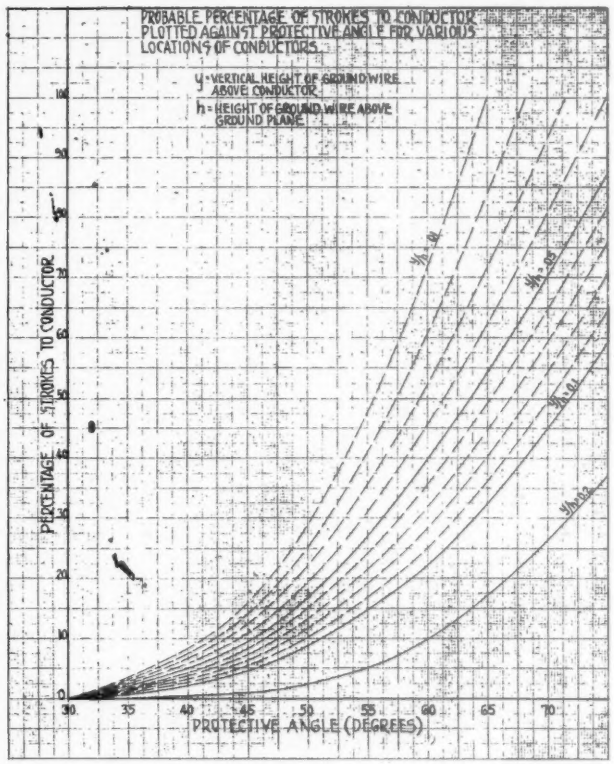

Fig. 6—Probable percentage of strokes to conductor plotted against protective angle for various locations of conductors.

due to direct stroke to conductor for various protective angles on lines in the vicinity of Cincinnati.

The probability of direct stroke outages for various protective angles is shown graphically on Fig. 8. It is noted that in the development of the curves that a definite cut off of 30 deg was used for the y/h curves. Although laboratory tests indicate that this cut-off point might vary with different ratios, it also proved that regardless of conditions if enough shots are observed, it was found that a stroke will finally strike the conductor. Using 30 deg as a definite cut-off point for these curves, therefore, injects a slight safety factor to provide for the antics of natural lightning.

The direct stroke outage curves shown on Fig. 8 were then plotted on Figs. 2 to 5 inclusive, using the 30 ft ground plane curve for the 5 and 10 ohm design curve and the 60 ft ground plane curve for the 20 and 30 ohm curves. The rapid rise of this direct stroke curve is due to the tangent scale resulting from plotting the protective angle along the abscissa to correspond with the height of the ground wire. These direct stroke curves now indicate the direct stroke outages per 100 mi per yr, which are caused only by strokes to the conductor and come as a result of improper shielding. We can now add the outages per 100 mi per yr due to strokes to the ground wire and the outages per 100 mi per yr due to improper shielding and obtain a curve which represents the probable total outages per 100 mi per yr for various heights of ground wire above conductor.

The total outage curve coincides with the back flash outage curves for protective angles less than 30 deg, but at values greater than 30 deg the direct stroke outages influence its shape. The outage curve decreases to a point at about 36 deg for all curves and from this point as the ground wire is lowered, the direct stroke outages become more prevalent and the curve begins to rise sharply. It is noted that this rate of increase decreases as ground resistances increase and at 30 ohms it appears possible to approach a protective angle of approximately 43 deg without consider-

Ground Plane = 30

x = Height of Ground Wire above Conductor	y/h	Protection Angle	% of Strokes to Conductor	Total Outage per 100 Miles per year based on 15.8 Strokes
1	.015	72°30'	----	----
1½	.0224	64°40'	75.5%	11.92
2	.03	57°45'	44.5%	7.04
2½	.0373	51°40'	23.5%	3.72
3	.04	46°30'	13.0%	2.05
3½	.052	42°10'	6.8%	1.08
4	.06	38°40'	3.5%	.55
5	.075	32°40'	.4%	.06

Ground Plane = 60

x = Height of Ground Wire above Conductor	y/h	Protection Angle	% of Strokes to Conductor	Total Outage per 100 Miles per year based on 15.8 Strokes
1	.01	72°30'	----	----
1½	.0154	64°40'	89.0%	14.0
2	.0206	57°45'	51.0%	8.06
2½	.0258	51°40'	27.0%	4.27
3	.0309	46°30'	15.0%	2.37
3½	.0361	42°10'	8.2%	1.30
4	.0412	38°40'	4.5%	.71
5	.0512	32°40'	.8%	.12

y = vertical height of ground wire above conductor
h = height of ground wire above ground plane

Fig. 7—Direct stroke outage curve for 33 Kv Standard Construction Isoceraunic Level = 50.

Ground Plane = 30

x = Height of Ground Wire above Conductor	y/h	Protection Angle	% of Strokes to Conductor	Total Outage per 100 Miles per year based on 15.8 Strokes
1	.015	68°	----	----
1½	.0224	59°	54%	8.54
2	.03	51°30'	25.5%	4.04
2½	.0373	45°	11.5%	1.82
3	.04	40°	5.8%	.917
3½	.052	35°30'	2.25%	.355
4	.06	32°	.50%	.078
4½	.067	29°	----	----
5	.075	26°30'	----	----
5½	.082	24°30'	----	----
6	.090	22°30'	----	----

Ground Plane = 60

x = Height of Ground Wire above Conductor	y/h	Protection Angle	% of Strokes to Conductor	Total Outage per 100 Miles per year based on 15.8 Strokes
1	.01	68°	----	----
1½	.0154	59°	61.5%	9.72
2	.0206	51°30'	29.0%	4.58
2½	.0258	45°	13.0%	2.05
3	.0309	40°	6.5%	1.03
3½	.0361	35°30'	2.8%	.44
4	.0412	32°	.75%	.12
5	.0512	26°30'	----	----

y = vertical height of ground wire above conductor
h = height of ground wire above ground plane

Fig. 7a—Direct stroke outage curve for 33 Kv Special Construction (Top Ins. 30" Out) Isoceraunic Level = 50.

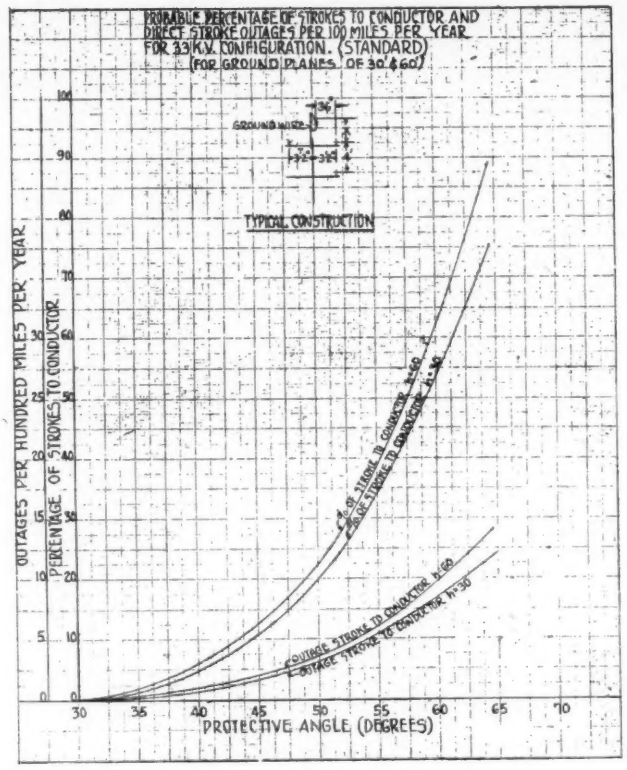
PROBABLE PERCENTAGE OF STROKES TO CONDUCTOR AND DIRECT STROKE OUTAGES PER 100 MILES PER YEAR FOR 33 K.V. CONFIGURATION. (STANDARD) (FOR GROUND PLANES OF 30' & 60')
GROUND WIRE
TYPICAL CONSTRUCTION
OUTAGES PER HUNDRED MILES PER YEAR
PERCENTAGE OF STROKES TO CONDUCTOR
% OF STROKE TO CONDUCTOR H=60
% OF STROKE TO CONDUCTOR H=30
OUTAGE STROKE TO CONDUCTOR H=60
OUTAGE STROKE TO CONDUCTOR H=30
PROTECTIVE ANGLE (DEGREES)

Fig. 8—Probable percentage of strokes to conductor and direct stroke outages per 100 miles per year for 33 Kv Configuration (Standard) (For ground planes of 30′ and 60′).

able increase in outages per 100 mi per yr.

We have in the vicinity of Cincinnati a limestone strata which gives as a rule, fairly low ground resistances. We therefore feel it possible to design lines, that is, pole lines with ground resistances as low as 5 ohms. It is therefore our intention to at least design our structures for 5 ohms ground resistance and if the line is not initially installed with sufficient rods to reach this level, we can improve our grounds periodically to approach this minimum. Taking into account mechanical features, present drilling in poles, etc., we selected as the best operating height in our particular case a height of ground wire above top conductor of about 4 ft 0 in. Note that on all our present construction indicated by Fig. 1, this distance is now only 2 ft 8 in, which gives a poor protection angle in addition to giving poor midspan clearance.

Although the resulting waves during a midspan flash were computed, it was impossible to plot curves giving required midspan clearance for this construction since we did not have available sufficient laboratory data to select a wave chopped at such a time as to be equivalent in sparkover characteristics to our calculated wave during stroke to midspan.

We therefore interpolated a midspan curve for 250 ft spans from previous articles referred to on tower lines. In sagging the conductors and ground wire the midspan clearance indicated in Fig. 14 should be maintained if at all possible. However, we believe that due to the probabilities involving a stroke at midspan that some shading in the matter will not greatly affect total outages.

Development of Special Rural Construction

Theoretically the voltage that results in the top conductor and that which results in the lower conductor during a stroke to the ground wire varies with the respective coupling factors. This theory would enable us to use a lower impulse value for the combined wood and insulator on the top phase than would be necessary for the lower combination.

This makes it possible to shift the top

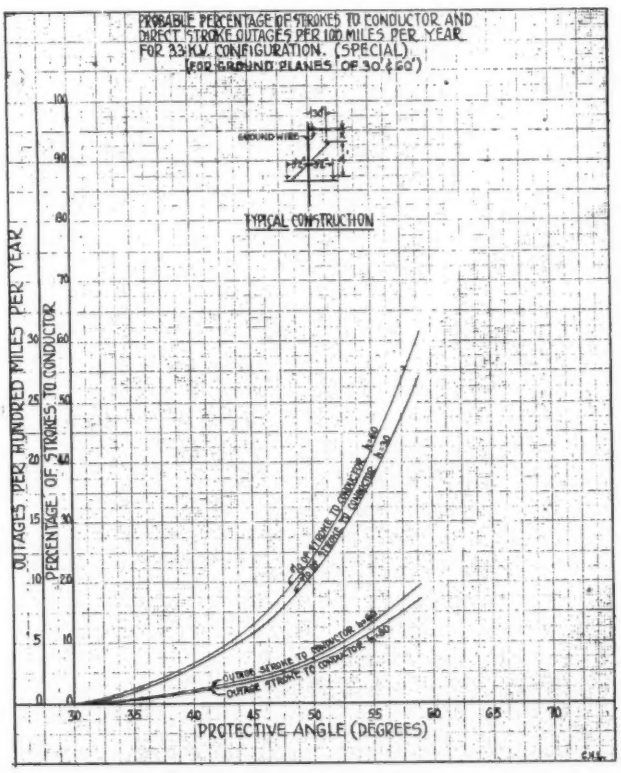
PROBABLE PERCENTAGE OF STROKES TO CONDUCTOR AND DIRECT STROKE OUTAGES PER 100 MILES PER YEAR FOR 33 KV. CONFIGURATION. (SPECIAL) (FOR GROUND PLANES OF 30' & 60')
GROUND WIRE
TYPICAL CONSTRUCTION
OUTAGES PER HUNDRED MILES PER YEAR
PERCENTAGE OF STROKES TO CONDUCTOR
% OF STROKE TO CONDUCTOR H=60
% OF STROKE TO CONDUCTOR H=30
OUTAGE STROKE TO CONDUCTOR H=60
OUTAGE STROKE TO CONDUCTOR H=30
PROTECTIVE ANGLE (DEGREES)

Fig. 9—Probable percentage of strokes to conductor and direct stroke outages per 100 miles per year for 33 Kv Configuration (Special) (For ground planes of 30′ and 60′).

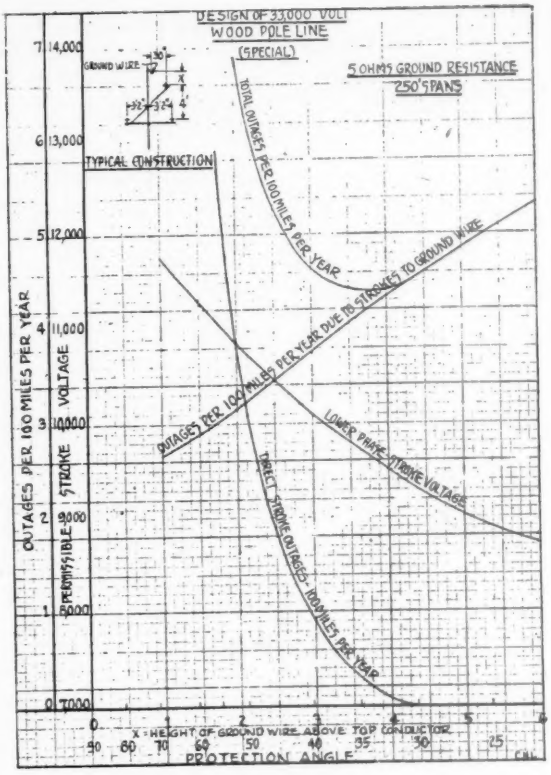
DESIGN OF 33,000 VOLT WOOD POLE LINE (SPECIAL)
5 OHMS GROUND RESISTANCE 250' SPANS
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
LOWER PHASE-STROKE VOLTAGE
DIRECT STROKE OUTAGES-100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 10

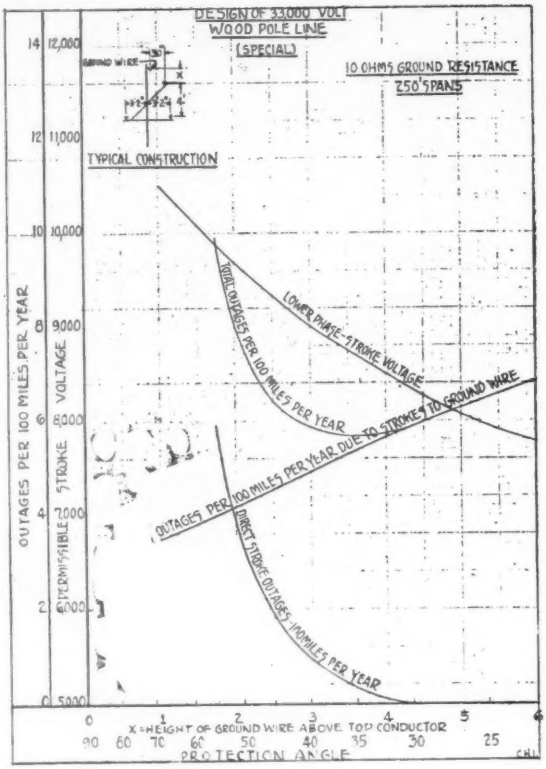
DESIGN OF 33,000 VOLT WOOD POLE LINE (SPECIAL)
10 OHMS GROUND RESISTANCE 250' SPANS
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
LOWER PHASE-STROKE VOLTAGE
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
DIRECT STROKE OUTAGES-100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 11

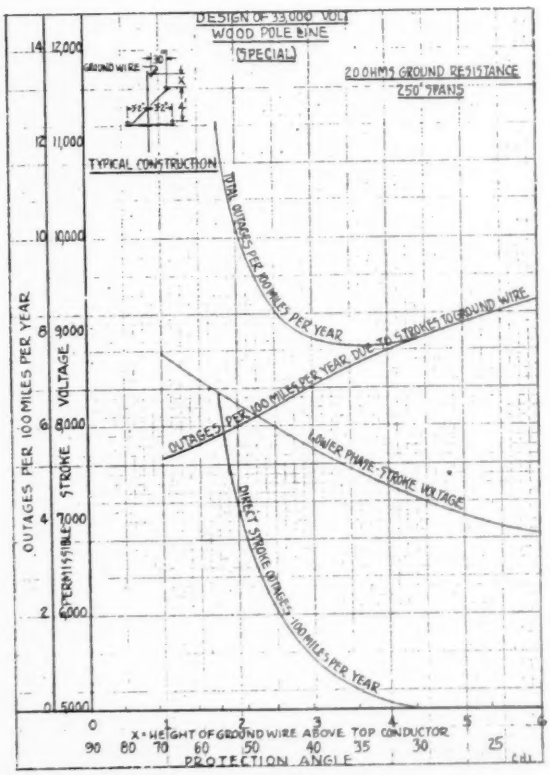
DESIGN OF 33,000 VOLT WOOD POLE LINE (SPECIAL)
20 OHMS GROUND RESISTANCE 250' SPANS
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
LOWER PHASE-STROKE VOLTAGE
DIRECT STROKE OUTAGES-100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 12

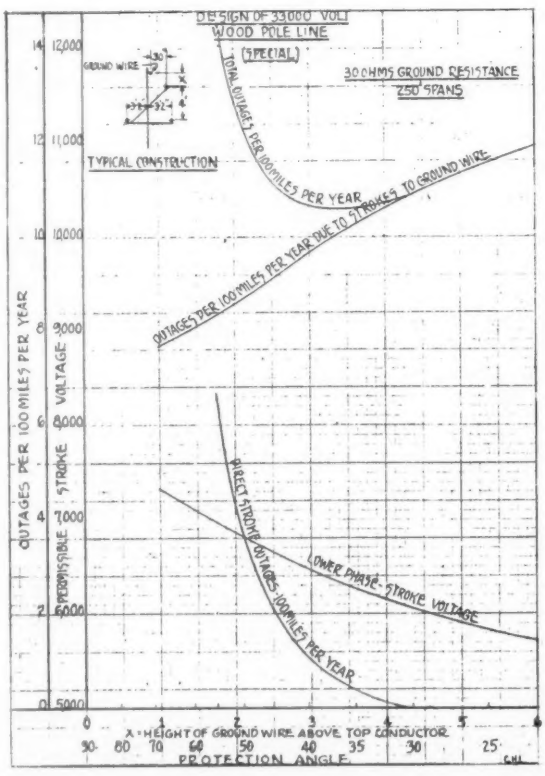
DESIGN OF 33,000 VOLT WOOD POLE LINE (SPECIAL)
30 OHMS GROUND RESISTANCE 250' SPANS
TYPICAL CONSTRUCTION
TOTAL OUTAGES PER 100 MILES PER YEAR
OUTAGES PER 100 MILES PER YEAR DUE TO STROKES TO GROUND WIRE
DIRECT STROKE OUTAGES-100 MILES PER YEAR
LOWER PHASE-STROKE VOLTAGE
OUTAGES PER 100 MILES PER YEAR
PERMISSIBLE STROKE VOLTAGE
X = HEIGHT OF GROUND WIRE ABOVE TOP CONDUCTOR
PROTECTION ANGLE

Fig. 13

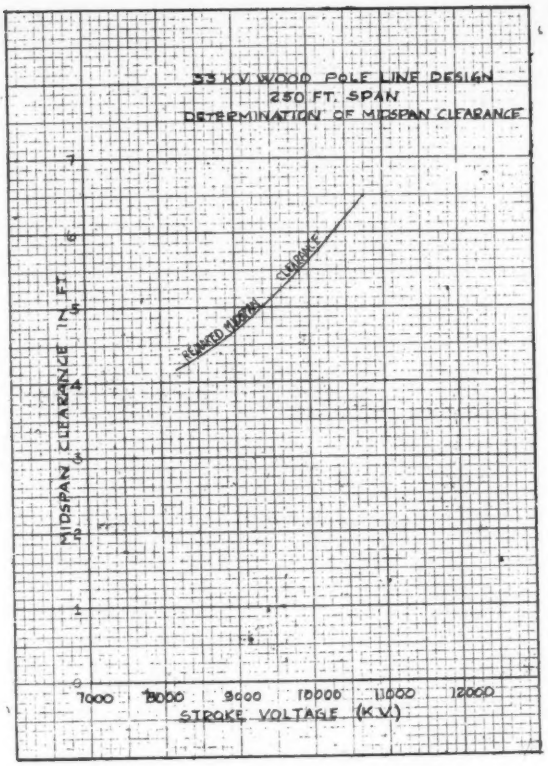

Fig. 14—33 Kv Wood Pole Line Design, 250 Ft Span, Determination of Midspan Clearance.

phase in toward the pole, thus decreasing the protective angle and permitting a reduction in the required height of ground wire which in turn would increase the coupling factor. The design curves shown on Figs. 9 to 13 inclusive, are based on this principal with the top insulator located 30 in from the center of the pole.

Actually it is possible by taking advantage of the ratio of the coupling factor, to further reduce this distance and still maintain a balanced electrical design, but we are dubious, without actual operating experience, to what extent we can rely on the coupling factor to reduce potential differences between ground wire and conductor. It is believed that the distance between ground wire and conductor should be sufficient to prevent spillover of the surge from ground wire to conductor. Although engineers have made remarkable strides in the theory of lightning and resulting effects in transmission lines, it is possible that for the present certain safety factors should be injected, particularly at the critical points.

The shifting of the top insulator lends itself to a construction similar to the old wishbone type construction which seems economical and sturdy. It is believed that this construction which is shown on Fig 16 can be used in rural territory as an economical construction using a light ground wire to replace present "Ridge Pin" construction without a ground wire. Although the operating characteristics according to our design curves are better than the standard construction, we feel that some operating experiences are necessary before a final decision is made.

Our present "Ridge Pin" construction is indicated on Fig. 15. The modified 33-kv construction developed permits the rebuilding of our "Ridge Pin" construction without removing the lower arm and without any field drilling. In mounting the new diagonal arm we utilize an existing brace bolt hole in the existing arm and use the existing hole now used in attaching the ridge pin bracket. A 4 in x 5 in x 10 ft timber is attached to the pole and serves as a support for the bayonet. The use of a wood bayonet is in line with conservation of steel in conjunction with our National Defense Policy and increases air gap clearances. We are now in the process of rebuilding approximately 13 mi of this ridge pin construction in the vicinity of Cincinnati.

Actual 33-Kv Line Operation

In order to determine just how close our theoretical calculations and design curves compare with actual operating records of our standard 33,000-v lines, we checked through our operating records and compiled the figures indicated on Fig. 17. These figures indicate the outage records per 100 mi per yr of all of our standard 33,000-v lines with ground wires for the past 11 yrs.

The average number of outages per 100 mi per yr for the 11 yr period is 8.88. This outage record is based on the configuration as shown on Fig. 1, with the standard height of ground wire above the top conductor of approximately 2 ft 8 in. The average resistance of our 33-kv construction is approximately 10 ohms. From Fig 3 the 10 ohm design curves for the standard 33-kv construction we find that the total outages per 100 mi per yr for a ground wire 2 ft 8 in above top conductor is approximately 7.75. This compares very favorably with the actual average outage figure of 8.88. There are, however, some factors to consider which alter this picture. Our 33-kv lines were all built with the configuration as shown on Fig. 1, but were originally installed with steel angle braces. We have throughout the years gradually replaced these braces with wood braces. Approximately 14.9 per cent of the record indicated represents wood braces.

The use of wood braces instead of steel braces reduces the permissible stroke voltage to the ground wire before flashover occurs by approximately 41 per cent. This results in a reduction of probable outages of 61.4 per cent. From the outage curves on Fig. 3 we find that at 2 ft 8 in the division of lightning outages is as follows:

4.60	Backflash outages
3.15	Direct stroke outages to conductor
7.75	Total

Assuming that the direct stroke outages to the conductor are unaffected by the use of steel braces, we need only correct our backflash outages to the percentage of steel braces representing the actual outage figure of 8.88. The new backflash outages per 100 mi per yr based on 85.1 per cent steel braces will be,

$$\frac{.851 \times 4.60}{(1 - .614)} = 10.12 \text{ outages per 100 miles per year}$$

The outage figure taken from our

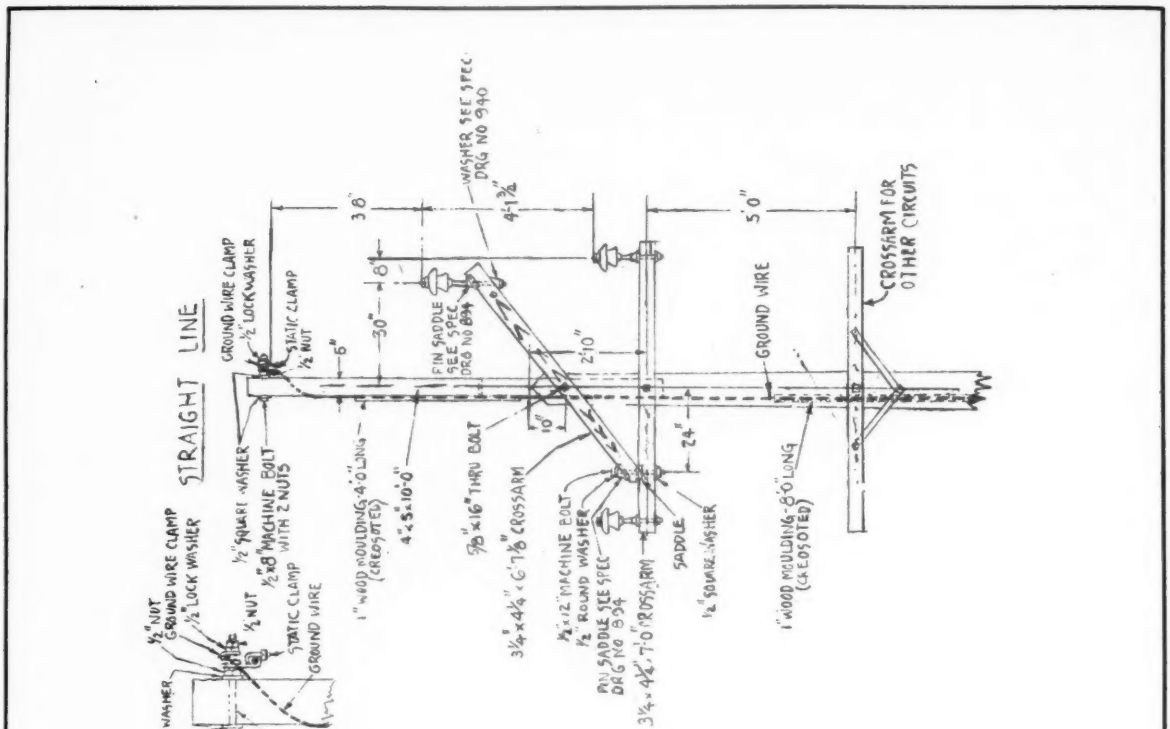

Fig. 16—33,000 Volt Construction (Special) for Rebuilding Ridge Pin Construction for use with Ground Wire.

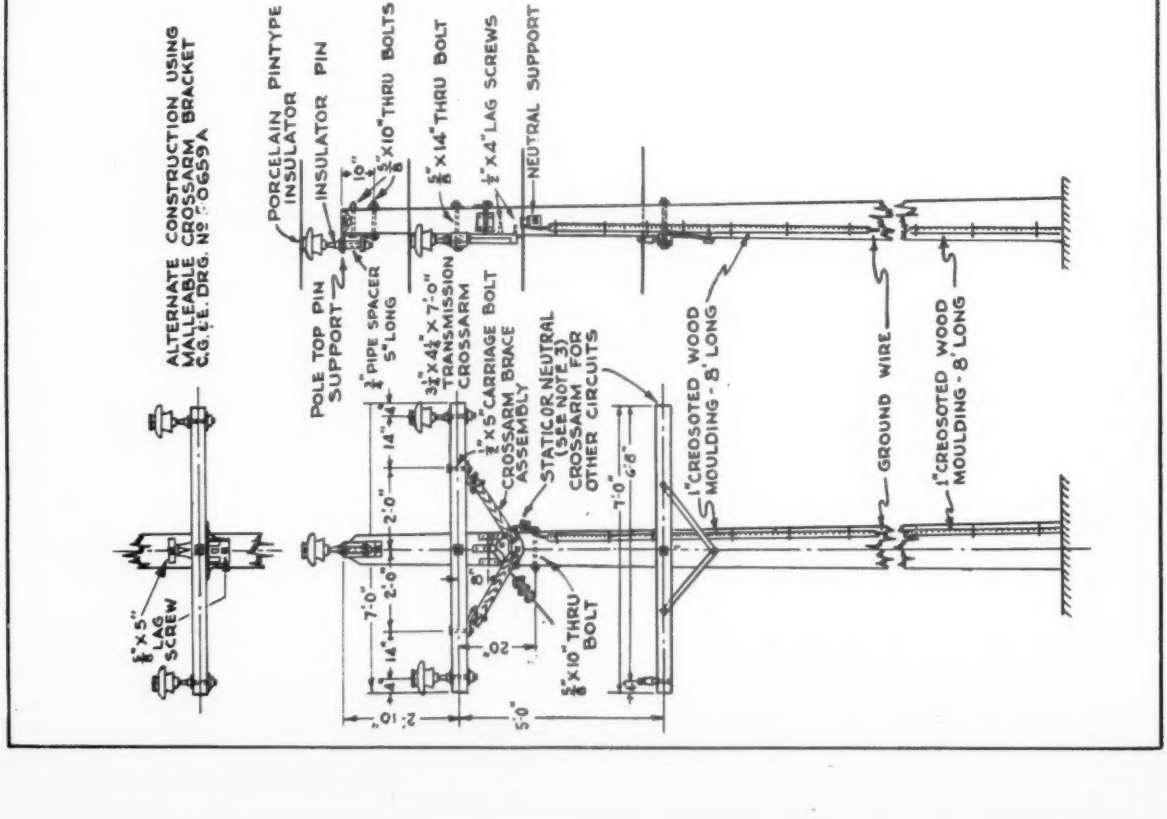

Fig. 15—33,000 Volt Overhead Construction

LINE	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	AVERAGE
551	8.58	17.17	30.70	23.0	31.32	0	35.6	7.26	21.8	0	0	14.2
651	24.0	0	23.0	0	17.6	0	17.6	5.70	5.70	0	0	9.75
851	23.2	23.2	9.4	4.68	4.68	4.68	9.40	4.68	23.5	9.40	0	11.10
852	14.18	14.18	0	0	0	0	0	0	28.36	0	0	5.15
853	17.65	8.82	8.82	8.82	8.82	17.65	13.25	0	13.25	0	0	8.72
2353	----	----	0	10.50	10.50	0	10.50	0	0	0	9.45	4.35
3151	2.66	5.30	8.0	2.75	2.75	5.58	5.58	5.58	18.65	7.95	7.95	6.72
AVERAGE	12.50	15.0	10.9	8.64	7.02	10.2	7.85	4.69	13.2	4.65	3.87	

Average number of outages per 100 miles per year for the 11 year period = 8.88

Fig. 17—Outage per 100 miles per year Record of 33,000 volt lines with ground wire and configuration as per Fig. 1.

design curve Fig. 3, comparable to the actual outage record, will therefore be,

	Per 100 miles per year
Backflash outage	= 10.12
Direct stroke outage	= 3.15
	13.27 outages

As can be seen, the actual outage record is lower than the theoretical outage record corrected to compensate for the use of a certain percentage of steel braces. We believe an explanation for the lower outage record (actual) is due to the shielding effects of hills, buildings, chimneys. trees. etc., in the vicinity of Cincinnati which would affect portions of these lines. Our calculations are based on fairly flat topography with no shielding effects.

Conclusions

While we are certain that these design curves are not beyond criticism or further development, it is believed that they can be used as a basis to design lines in an effort to reduce lightning outages.

The probable outage record (Outages per 100 mi per yr) of the various 33-kv constructions as taken from the design curves may be summarized as follows:

	5 ohms	10 ohms	20 ohms	30 ohms
Present 33-kv Construction (Ground wire 2′8″ above top conductor)	6.65	7.75	10.1	12.8
Minimum Outage Record Standard Construction (Ground wire approximately 4′5″ above top conductor)	4.85	6.1	8.25	11.3
Minimum Outage Record Special Construction (Ground wire approximately 3′6″ above top conductor)	4.40	5.65	7.70	10.6

This would indicate that the special construction would give a better operating record and still require less bayonet height than the standard construction.

As mentioned previously, we are doubtful as to what extent we can rely on coupling factor and to what point this top phase can be safely moved in without a spillover. The results can only be definitely ascertained by operating experiences.

We would suggest that if it is desirable to maintain a high insulation level on a 33-kv line that the modified "Wishbone Construction" be used with 9 or 10 ft crossarms. We believe that this construction would result in an excellent operating record, without increasing the bayonet height excessively.

In making our calculations we included the effects of the corona on the conductor to establish effective diameters. It may be doubtful that the effect of corona need be considered for wood pole lines with short spans. Certainly it should be considered for long spans on lines having high insulation strength. From actual results, however, we are of the opinion that corona effects should not be ignored in considering the 33 kv. lines of the type discussed.

These design curves are based on average probable outage experience and cannot be compared to actual experiences with short lines over short periods. We know that a line in a certain location will operate with an excellent record and another of similar characteristics in another location will operate with a poor record. This may be due to shielding effects or it may be due to the fact that the one line is located along or near a river or some natural barrier along which the majority of the storms in that vicinity are sure to follow. There is also a great difference in outages from year to year. This is indicated on Fig. 17. The only records, therefore, which are representative are those compiled over a great area and over a considerable number of years.

It is our intention to continue our efforts along the line of development of proper design curves based on future outage experience and the results of the excellent efforts of Research Engineers in our Electric Laboratories.

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"What Wood May Add to Primary Insulation for Withstanding Lightning" by Lusignan, Jr., and Miller. A.I.E.E. Paper, December, 1939.

"Traveling Waves on Transmission Systems" by L. V. Bewley.

Better Copy Contest Awards Announced at PUAA Convention

REPRESENTATIVES of 61 electric, gas, water and transportation utilities from all sections of the United States received 119 awards for prize-winning advertisements at the annual convention of the Public Utilities Advertising Association, held in New York, June 22-24. 1400 entries were received and judged by the Judging Committee of the 1942 Better Copy Contest. Out of these entries 119 national and regional awards were made.

A permanent record of the prize winning advertisements was reproduced in a large 68-page booklet and distributed to the membership. These reproductions of utility advertising published through the period January 1 to December 31, 1941, are interesting specimens of utilities' use of all media of advertising and publicity. Of special interest is the theme of advertising, as it underwent a sudden, radical change since December 7.

National Awards announced by the Chairman of the Better Copy Contest included: *Public Relations Newspaper Adv.*, The Cincinnati Gas and Electric Co.; *Electric Load Building Newspaper Adv.*, Public Service Electric and Gas Co.; *Electric Merchandise Newspaper Adv.*, Indianapolis Power and Light Co.; *Gas Merchandise Newspaper Adv.*,

(*Continued on page* 284)

Canadian Electrical Association Convention

THE 52nd Annual Convention of the Canadian Electrical Association was held at the Seigniory Club, Quebec, on June 11 and 12.

In opening the Convention, McNeely Du Bose, President of the C.E.A. and general manager of the Saguenay Power Company, Ltd., said that when the war began Canada had an installed generating capacity of 7,600,000 hp, load factor of 57 per cent and a reserve of 2,400,000 hp over firm power peaks. At the end of March, 1942, he said, the industry had added 700,000 hp of new generating equipment and had raised load factor to 70 per cent. Looking to the future, Mr. Du Bose said:

"Our manufacturers are now producing generating equipment at the remarkable rate of more than ¾ of a million horsepower a year, enough to keep pace with our established rate of expansion, but the weight of this new influx of new power will not be greatly felt before the summer of 1943, and in the meantime that margin between total peak load and firm peak load, which has stood us in such good stead, is now down to 1,300,000 hp of which half is exported to the United States for use in war industries. The balance, although consumed in electric boilers, and, in theory, available for conversion to primary uses, is in fact so inaccessible of location, or is so chopped up filling in load recessions, that it is practically intangible for primary use. So, to keep up our established pace of supplying power to expanding war industries, we must look to other sources.

"What are these sources? There is no use beating around the bush. They are peak load control and power rationing of non-essential power uses. And unless we are blessed with exceptionally good water conditions this fall and winter, or unless there is a considerable automatic drop in the amount of power used by non-essential industries, we electrical men will know a lot more about peak load control and power rationing before we meet next year."

B. C. Fairchild, Secretary of the Association, in his annual report stressed the value and necessity for the continued operation of many of the Association Committees under present conditions, by pointing out the many new subjects under study by these groups, which are a direct result of the war.

He also referred to the great increase in various regulations and restrictions placed upon the home and industrial life of Canada as a result of the war and outlined the increased work of the Association Headquarters in disseminating up-to-date and authentic information in this respect.

The Managers Committee reported on a variety of important subjects including taxes, priorities, meter test period, salvage, rationing of gasoline and tires, and various government regulations affecting utility operations.

The Rate Structures Committee reported on the effect on utility rates of the Maximum Price Regulations and submitted the replies to a questionnaire on the subjects of "Tests on an A.C. Welder" and "Rural Service and Line Extension" policies.

The report of the Lighting Committee included the data on new lamp developments and commercial, domestic and industrial lighting, with a special report on "Protective Lighting." The use of high frequency received the attention of the Industrial Power and Heating Committee which also reported on the latest developments in infra-red heating, powder metallurgy and ventilation, in addition to other subjects.

This Committee received special congratulation for its preparation of a booklet entitled "Uses of Electric Heat in Industry" which had been mimeographed and distributed through the Secretary's Office and should be of great value to all engaged in promotional work.

The first two prize-winning papers submitted in the essay contest sponsored by this Committee were read by their authors at the opening session on the second morning.

The Metering Equipment Committee reported giving special attention to the availability of meters and to proper meter cleaning solutions as a necessity for prolonging the life of these instruments. A final report on the "Reconditioning of Insulating Oils" and additional valuable information on "Improved Generator Cooling" constituted the most important studies reported by the Electrical Equipment Committee, while the Power Systems Engineering Committee drew to the attention of members the "Effects of the War on Design and Operation of Electric Systems in Canada."

The Motor Vehicles Committee confined their report to pertinent suggestions on maintenance and conservation of gasoline and tires.

With rubber and tin fast becoming unobtainable the Wiring Committee discussed conservation of these vital materials and what is being done to find substitutes.

The Grounding Committee this year reported on the systems in Vancouver and Winnipeg in addition to publishing valuable information as to the standard practice of one electric power company on "The Electrical Thawing of Water Pipes."

A preliminary study on concrete for use on duct lines and in manholes was reported on by the Underground Systems Committee and a comprehensive

(*Continued on page* 284)

Officers and Executive Committee of the Canadian Electrical Association
Left to right: R. N. Coke; B. C. Fairchild, Secretary; R. A. Merritt; H. A. Cooch; C. R. Reid; J B. McCabe, Treasurer B. M. Hill; George Kirlin; F. T. Wyman; J. B. Hayes, Vice President; W. C. Mainwaring, President; Alan Brown, Vice President; H. E. Pawson and I. M. McLean.

PERSONALS

ALFRED C. MARSHALL, president of The Detroit Edison Company, has been elected to the board of lifetime trustees and made vice president of the Horace H. Rackham Engineering Foundation, to succeed the late Alex Dow. Mr. Marshall is also serving as treasurer of the foundation. The foundation was created to receive and disburse funds received from the Horace H. Rackham and Mary A. Rackham Fund for the benefit of the Engineering Society of Detroit.

J. W. MCAFEE, president of the Union Electric Company, St. Louis, has been appointed general chairman of the Greater St. Louis War Chest Campaign, which will be conducted this fall to provide funds for the support of various charitable, war relief and character building agencies of the city of St. Louis and St. Louis County.

GEORGE C. MATHEWS, first vice president of Northern States Power Co. (Del.) will become associated with the Public Utility Engineering and Service Corp., a subsidiary of Standard Gas and Electric Company, to relieve LEO T. CROWLEY, president of Standard Gas and Electric Co., of various duties. Mr. Mathews has resigned as a director of Northern States Power Co. and expects to assume his new duties on August 1.

Prior to his association with Northern States Power Co., Mr. Mathews was a member of the Securities and Exchange Commission, having been appointed to that board in 1934. He resigned in 1940 to become a vice president of Northern States Power Company.

GEORGE H. SMITH, formerly managing director of the Empire State Gas and Electric Association, has been made chief of the Priorities section handling PD-1A applications for the power branch of the War Production Board. Mr. Smith began his utility career in 1911 after graduating from college with a civil engineering degree. He was connected with the Central Hudson Gas and Electric Corp. from 1911 to 1926 as chief gas engineer and assistant electrical engineer. During the past fifteen years he was connected with the Empire State Gas and Electric Association as its engineer and managing director. The association was dissolved last year.

ROBERT J. O'CONNELL, formerly customer service representative for the Arkansas Power and Light Co. at Searcy, has been named division sales manager for the Southeast division with headquarters at McGehee. Mr. O'Connell has been a member of the sales department staff since 1938.

VINCENT C. BRENNAN has been appointed executive director of personnel of the Union Electric Company, St. Louis. Mr. Brennan was formerly connected with the eastern division of the Tidewater Association Oil Company of Bayonne, N. J., where he was in charge of industrial relations. He has served as a member of the panel of the training within industry group of WPB at Newark, N. J.

JOSEPH W. HICKS has opened an office as public relations-industrial relations counsel with headquarters at 333 North Michigan Avenue, Chicago. For many years Mr. Hicks was connected with the Byllesby Engineering and Management Corp. and later with the Public Utility Engineering and Service Corp., Chicago, as publicity director.

FREDERICK X. KAIER, supervisor of sales analysis since 1931, has been appointed assistant to the vice president in charge of sales of the Philadelphia Electric Co. Mr. Kaier studied mechanical engineering at Pennsylvania State College and was first employed by the Philadelphia Electric Co. in 1922 as a station inspector. Subsequently he was transferred to the sales department and was made supervisor of market analyzers.

S. J. MCKELVY has been appointed head of the engineering division of the underground and transmission construction department just formed by the Public Service Electric and Gas Company, Newark, through the merger of the engineering sections of the underground division and of the transmission division. The headquarters section of the department has been discontinued and the transportation and the stores groups of that section assigned to the underground division under A. F. RANDOLPH, underground construction engineer. The shop group has been assigned to the transmission and construction division, under FRED H. LEGGE, transmission construction engineer.

WILLIAM H. CHAMBERLAIN, Perth Amboy district superintendent, electric distribution department of the Public Service Electric and Gas Co., Newark, has retired after nearly forty-seven years with the company and its predecessors.

S. B. WAY, president of the Wisconsin Electric Power Co., Milwaukee, was awarded the honorary degree of doctor of science by his alma mater, Drexel Institute of Technology, at the recent commencement exercises in Philadelphia, Pa.

GEORGE W. HART, sales consultant for Ebasco Service, Inc., since 1936, has resigned to join the Government Contract Service staff of the Radio Division of Western Electric Company, Inc., at 120 Broadway, New York.

For the past two years Mr. Hart has been chairman of Edison Electric Institute's Wiring Committee, and a member of the Planning Committee of the National Adequate Wiring Bureau.

Mr. Hart graduated in electrical engineering from Bucknell University in 1927. After several years in electrical work for Bethlehem Steel Company and the Pennsylvania Railroad he began his electric utility connections as commercial engineer with New York and Queens Electric Light and Power Company. Graduate study in public utility economies at New York University led to his subsequent position with Ebasco Service.

GEORGE W. OUSLER has been elected vice president in charge of sales, Duquesne Light Company, Pittsburgh, Pa., PRESSLY H. MCCANCE, president of the company, announced recently. Mr. Ousler replaces Joseph McKinley, who retired June 1 after 39 years of service with the company.

A native of Boston, Mr. Ousler was graduated from the Massachusetts Institute of Technology in 1916, and immediately entered the service of the Philadelphia Company (of Pittsburgh) Engineering Department. In 1927 he was made director of sales engineering, and in 1929, manager of rates and retail service. In 1931 he was made general sales manager, which included supervision of the home service and rate departments. He held this position until his recent promotion.

Idle Generating Capacity

(*Continued from page 255*)

—Locate new plants near available sources of supply to reduce losses—also to reduce critical materials
—Select efficient electrical equipment
—Set up capacities, processes and working schedules to keep peaks down, just as outlined above for present plants

B—Commercial Possibilities

1—Air conditioning and refrigeration

—Shift all air conditioning and unnecessary refrigeration to off-peak hours
—Shift necessary refrigeration to off-peak hours wherever storage capacity is sufficient for carryover

2—Lighting

—Use automatic control equipment to reduce show window, sign and other unessential lighting during on-peak hours
—Curtail flood lighting and commercial sports field lighting

3—Heating

—Shift all electric space heating to off-peak periods
—Shift electric water heating to off-peak hours wherever sufficient carryover is available
4—Other; analyze all load-shifting or load-molding possibilities fully

C—Government & Municipal Possibilities

1—Non-essential services

—Shift all air conditioning and, where possible, ventilation to off-peak hours
—Curtail public sports field and flood lighting
—Limit any other curtailable uses

2—Essential services

—Shift water pumping and irrigation where possible to off-peak periods
—Reduce street lighting where possible during on-peak periods
—Cut or shift other load peaks, if possible, as in industrial plants

D—Transportation Possibiiities

1—Heating

—Operate electric heating apparatus only during off-peak hours

2—Motive power

—Stretch out schedules of street car and electric bus operation during power peak periods wherever transportation peak is not coincident with power system peak

E—Residential Possibilities

1—Heating

—Encourage staggering of ironing load if it comes on peak
—Discourage use of electric space heaters and other electric heating loads during peak periods

2—Other

—Discourage waste at all times or unnecessary use of such services as radio or lighting during on-peak hours

F—Utility Possibilities

1—Promote conservation of use in company offices, plants and stores

CONVENTIONS AND MEETINGS

1942

SEPTEMBER

11	Pennsylvania Electric Association, Bellevue-Stratford Hotel, Philadelphia, Pa.
21-22	Illuminating Engineering Society, Jefferson Hotel, St. Louis, Mo.
24-25	Indiana Electric Association, Indianapolis, Ind.

OCTOBER

5-9	National Safety Council Congress, Chicago, Ill.
14-16	American Institute of Electrical Engineers, Pittsburgh, Pa.
26-30	National Electrical Manufacturers Association, Waldorf-Astoria Hotel, New York, N. Y.

Canadian Convention

(*Continued from page 282*)

suggestion relating to "Cable Engineering Data" was offered for the guidance and information of smaller purchasers of cable.

The Overhead Systems Committee continued the work already undertaken by standing sub-committees. Agreement has been reached on a restricted list of items of pole-line hardware in general use by member companies and a Canadian Engineering Standards Association Committee studying this subject have benefitted by previous activities of this group.

An analysis of the "Ground Line Treatment of Standing Poles" after two years' service was made by the sub-committee on Preservative Treatment of Poles, in conjunction with the Forest Products Laboratories, Ottawa, which should prove of interest and value to all pole users. Further data on the "Loading and Testing of Distribution Transformers" was published by this sub-committee.

Special speakers were heard during the luncheons on the first and second days of the meeting and at a dinner on the evening of the first day.

The following officers were elected for the coming year:

President: W. C. Mainwaring, General Sales Manager, British Columbia Electric Railway Company and Chairman, Provincial Civilian Protection Committee, Vancouver, B. C. Vice-presidents: R. A. C. Henry, Vice-President, Montreal Light, Heat & Power Cons., Montreal; Alan Brown, Manager Eastern Distribution District, Gatineau Power Company, Ottawa; and J. B. Hayes, Manager, Nova Scotia Light and Power Company Ltd., Halifax, N.S.

J. B. McCabe and B. C. Fairchild were re-elected Treasurer and Secretary respectively, while new members elected to the Executive Committee included J. K. Wilson, H. E. Pawson and F. T. Wyman, while the appointment of T. Ingledow and E. C. McGovern, made during the year, will continue.

Better Copy Contest Awards

(*Continued from page 281*)

Pacific Gas and Electric Co.; *Gas Load Building Newspaper Adv.,* Boston Consolidated Gas Co.; *Campaigns,* The Connecticut Light and Power Co.; *Transportation Newspaper Adv.,* Wisconsin Public Service Corp.; *Employee Magazine,* Niagara Hudson Power Corp.; *Employee Newspaper,* The Cincinnati Gas and Electric Co.; *Residential Bill Enclosures,* Southern California Edison Co. Ltd.; *Residential Direct Mail,* The Connecticut Light and Power Co.; *Industrial and Commercial Direct Mail,* Nebraska Power Co.; *Special Booklets,* West Penn Power Co.; *Window or Inside Display,* Philadelphia Electric Co.; *Outdoor Advertising,* Philadelphia Electric Co.; *Radio Advertising,* Duquesne Light Co.; *Annual Reports,* Texas Power and Light Co.; *Motion Pictures,* Pacific Gas and Electric Co.

The P.U.A.A. Convention was hailed as an outstanding success. Attendance was perhaps the largest in the history of the organization and the addresses, without exception, made valuable contributions to war advertising knowledge.

Clara H. Zillessen, advertising manager, Philadelphia Electric Company, was elected president of the Association for the 1942-1943 term succeeding Al C. Joy of San Francisco. Miss Zillessen was also re-elected secretary of the Advertising Federation of America which held its annual convention simultaneously.

Other officers named were: first vice-president—Thomas H. Spain, Public Service Electric and Gas Co., Newark; second vice-president—J. V. MacDonald, Boston Edison Co.; third vice-president—R. I. Seymour, Kansas City Power and Light Co.; secretary—Waldo M. Wright, Amarillo Gas Co.; treasurer—Dale Remington, Wisconsin Public Service Corp., Green Bay.

OFFICERS AND COMMITTEES OF THE EDISON ELECTRIC INSTITUTE

1942-1943

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W. E. MITCHELL, Georgia Power Co., Atlanta, Ga.

RALPH MOODY, Union Electric Co. of Missouri, St. Louis, Mo.

JAMES H. POLHEMUS, Portland General Electric Co., Portland, Ore.

W. H. SAMMIS, The Commonwealth & Southern Corp., New York, N. Y.

CHESTER C. SMITH, Kansas City Power & Light Co., Kansas City, Mo.

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E. C. STONE, Duquesne Light Co., Pittsburgh, Pa.

L. V. SUTTON, Carolina Power & Light Co., Raleigh, N. C.

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E. S. THOMPSON, American Water Works & Electric Co., New York, N. Y.

G. W. VAN DERZEE, Wisconsin Electric Power Co., Milwaukee, Wis.

H. E. YOUNG, Northern States Power Co., Minneapolis, Minn.

P. S. YOUNG, Public Service Electric & Gas Co., Newark, N. J.

CHAIRMEN OF THE COMMITTEES

Accident Prevention, GEORGE S. DIEHL, Pennsylvania Water & Power Co., Baltimore, Md.

Accounting Executive, F. B. FLAHIVE, Columbia Gas & Electric Corp., New York, N. Y.

Customers' Relations, Commercial Accounting and Collections. (To be appointed.)

Depreciation. (To be appointed.)

General Accounting. (To be appointed.)

Plant Accounting and Records. (To be appointed.)

Purchasing Stores and Transportation. (To be appointed.)

Electrical Equipment, R. T. HENRY, Buffalo Niagara & Eastern Power Corp., Buffalo, N. Y.

Hydraulic Power. (To be appointed.)

Insurance, J. H. NICKELL, Philadelphia Electric Co., Philadelphia, Pa.

Membership, EDWARD REYNOLDS, Columbia Gas & Electric Corp., New York, N. Y.

Meter and Service, H. A. HOWERY, Kansas City Power & Light Co., Kansas City, Mo.

Prime Movers, J. A. KEETH, Kansas City Power & Light Co., Kansas City, Mo.

Prize Awards, P. S. YOUNG, Public Service Electric & Gas Co., Newark, N. J.

Rate Research, F. A. NEWTON, The Commonwealth & Southern Corp., New York, N. Y.

General Commercial, EDWIN VENNARD, Middle West Service Co., Chicago, Ill.

Statistical, W. G. BOURNE, JR., The Commonwealth & Southern Corp., New York, N. Y.

Transmission and Distribution, E. V. SAYLES, The Commonwealth & Southern Corp., Jackson, Mich.

Codes and Standards (a Subcommittee of the Operating Committee) H. B. BRYANS, Philadelphia Electric Co., Philadelphia, Pa.

BOARD OF TRUSTEES
OF THE
EDISON ELECTRIC INSTITUTE

1942-1943

(*Terms expiring* 1943)

PHILIP G. GOSSLER.....Columbia Gas & Electric Corporation, New York, N. Y.
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K. M. ROBINSON.....The Washington Water Power Company, Spokane. Wash.
P. L. SMITH.....Middle West Corporation, Chicago, Ill.
GEORGE N. TIDD.....American Gas & Electric Company, New York, N. Y.
JOHN E. ZIMMERMANN.....The United Gas Improvement Company, Philadelphia, Pa.

(*Terms expiring* 1944)

D. C. BARNES.....Engineers Public Service Company, New York, N. Y.
SAMUEL FERGUSON.....The Hartford Electric Light Company, Hartford, Conn.
C. E. GROESBECK.....Electric Bond and Share Company, New York, N. Y.
W. J. HAGENAH.....Public Utility Engineering & Service Corp., Chicago, Ill.
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(*Terms expiring* 1945)

JAMES B. BLACK.....Pacific Gas and Electric Company, San Francisco, Cal.
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C. W. KELLOGG.....Edison Electric Institute, New York, N. Y.
B. W. LYNCH.....San Diego Gas & Electric Co., San Diego, Cal.
A. C. MARSHALL.....The Detroit Edison Company, Detroit, Mich.
A. B. PATERSON.....New Orleans Public Service Inc., New Orleans, La.
H. HOBART PORTER.....American Water Works & Electric Company, Inc., New York, N. Y.
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